# A MANUAL OF BOOT AND SHOE MANUFACTURE

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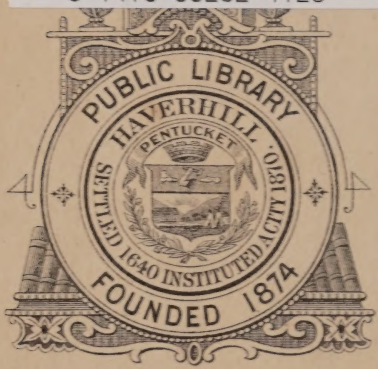


NATHANIEL E. NOYES FUND

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A MANUAL OF

# Boot & Shoe Manufacture

DESIGNED

FOR THE USE OF TECHNICAL STUDENTS

BY

**H. HILL and H. YEOMAN**

*THIRD EDITION*

REVISED AND PARTLY RE-WRITTEN

BY

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TO

QUINTIN HOGG, ESQUIRE,

THROUGH WHOSE MUNIFICENCE

THE FIRST CLASSES

FOR INSTRUCTION IN THE

TECHNOLOGY OF BOOT AND SHOE MANUFACTURE

WERE ESTABLISHED,

**This Work is Dedicated**

AS A TOKEN

OF THE AUTHORS' REGARD AND

ESTEEM FOR

HIS NOBLE PERSONALITY

AND WORK

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# PREFACE TO THE FIRST EDITION.

THE "MANUAL OF BOOT AND SHOE MANUFACTURE" is chiefly intended to serve the purpose of a text-book for students preparing for the technological examinations; but it is hoped that it may also prove of benefit to that large body of workmen who are unable, from various causes, to avail themselves of such benefits as accrue from a course of technical instruction.

In the Manual now submitted, some of the theories advanced are entirely new; but attention is not directed to them merely on that account. Their truthfulness has been demonstrated in practical experience, and there is reason to hope that they may prove of advantage to the many concerned in the construction of boots and shoes.

That amount of pure unapplied science which is essential to the proper understanding of the after chapters has been embodied in the early portions of the work. The utility of the problems submitted in the second chapter must be apparent to all.

The method of tuition recommended in the chapter on pattern cutting has proved eminently successful. Students who had the crudest ideas of the principles of patterns have been enabled, at the end of their first session, by an observance of the rules given, to cut an almost perfect standard pattern from a last, without any other guides whatever. In the whole of the matters treated —sole shapes, clicking, fitting, rough stuff cutting, finishing, and machinery—the constant endeavour has been to give the "why" and the "wherefore" of all the processes treated.

It will be well, however, for both teachers and students to remember that the technical knowledge which is obtainable by a perusal of books and articles, though of the very highest importance, is only useful as a means whereby auctual workmanship may be rendered more exact and easy of accomplishment. It is recommended, therefore, that teachers should plainly demonstrate the applicability of those theories they inculcate, and that in all their lessons they should always endeavour to render their instruction both sound and thorough.

By the proper use of the questions appended to each chapter it is hoped that the task of the teacher in testing the knowledge of the student may be facilitated.

## PREFACE TO THE SECOND EDITION.

THE first large edition of "THE MANUAL" being now exhausted a fresh edition is called for, and occasion has been taken to slightly re-model the work and to revise the text in such parts and in such manner as the more mature experience of the author has suggested as desirable, and as the development of the industry and the progress of the Technical Education movement has rendered necessary. In one department of the work—that on Pattern Cutting—information is given which was absent in the first edition, which was specially designed for elementary students. Whilst, however, the Manual in no essential degree departs from the original plan, it has been thought desirable to render its survey of the entire industry more complete by supplementing the information having reference to this most important part of the industry. Some reasons, too, for the maintenance of the opinion as to the artistic basis of Standard Pattern Designing—an opinion which has been hotly ridiculed—will be found in the chapter devoted to that subject.

Some information has also been embodied bearing upon the production of machine-welted work, and in other respects the work has been brought up to date.

In conclusion, I have to regret the loss of the help of my former friend and colleague, Henry Yeoman, in the revision of this work, with which I desire still to associate his name.

HERBERT HILL.

East Finchley, N., November, 1892.

## NOTE TO THE THIRD EDITION.

THIS edition has been carefully revised and partly re-written. Questions have again been placed at the close of each chapter, and it is hoped that the usefulness of the book may be still further appreciated as an introduction to the Technology of Shoe Manufacture.

HERBERT HILL.

East Finchley, N., May, 1900.

# A Manual of Boot and Shoe Manufacture.

## CHAPTER I.

### The Anatomy of the Foot.

Authorities:—"The Foot," by T. S. Ellis (Churchill)—"The Human Foot," by Dr. Rhys (Burlington Publishing Co., Ltd.)—Dr. Hepburn, in "Chambers's Encyclopædia" (article, "Foot").

NOTHING strikes the student of boot and shoe manufacture as a greater incongruity than that an acquaintance with the rudiments of anatomy is essential to a proper progression in a course of instruction in boot and shoe manufacture. Yet, that such is the case is readily seen when we consider that any attempt to clothe the foot in such a manner as to meet its every requirement must be on the basis of a previously acquired knowledge as to the construction and peculiar requirements of the foot. Hence, then, if bootmakers desire to clothe the foot rightly, the anatomy and functions of the human foot, and its requirements for a healthy action, must be their study. The knowledge of anatomy that the technical student should strive to acquire should be distinguished not so much from its minuteness as for its broad grasp of important principles, and its general knowledge of the nature of the component parts of the foot and of their normal functions. Accordingly, it is these important principles of the foot's construction and mechanism that will be mainly dealt with in this chapter.

Broadly speaking, the foot is composed of bone, fleshy matter, and skin. These divisions, of course, ad-

mit of several sub-divisions; but it will be sufficient for our purpose to treat of the foot's constituents under these heads alone.

One of the principal characteristics of the foot is its bony nature; probably, next to the hand, it is the most bony member of the human body. The bones form the framework or skeleton of the foot, and in combination with the muscles are a means of locomotion. In all, there are twenty-six bones in each foot, the several bones being united to each other by means of ligaments. These bones fall into three natural divisions or groups: The back part, named the Tarsals; the middle, the Metatarsals; the toes, called the Phalanges. The highest of the Tarsals is the Astragalus, and this works between the two long bones of the lower leg, and forms

Fig. 1.—The Dorsal Aspect of the Tarsal Bones of the Left Foot.

cm, Calcaneum; as, Astragalus; n, Scaphoid; c1, c2, c3, the three Cuneiform bones; cb, the Cuboid.

the ankle. The Astragalus rests below upon the large bone forming the heel, in a saddle-like manner. In front of the Astragalus, on the inner side of the foot, is the Scaphoid. Between the Scaphoid and the Cuboid are the three Cuneiform bones. Each Metatarsal bone is connected with one or more of the Tarsal bones. To each of the smaller toes there are three phalanges, and two of them form the great toe.

The place where two bones are united is termed a "joint." There are several different kinds of joints, many examples being found in the union of the bones of the foot.

This segmental construction of the foot gives elasticity to it, and this end is still further attained by the interposing of layers of cartilage where the bones articulate with one another. Were it not for this arrangement, when one jumped upon the forepart of the foot a violent concussion would be sustained. At the hinder

part of the foot this provision is less marked. Hence, when jumping, it is instinctive to alight without first touching the ground with the heels; and the difference of the effect of the arrangement is but too well understood when, from some accidental cause, in so jumping from a height, the heels touch the ground first.

It is to be remembered that in different parts of our body we have different kinds of motion, so it is easy to understand how the joints must be of different shapes. In the ankle and foot, for instance, flattish bones have to be used so as to glide a little, one upon the other. The gliding joint allows a slight motion, such as is given to

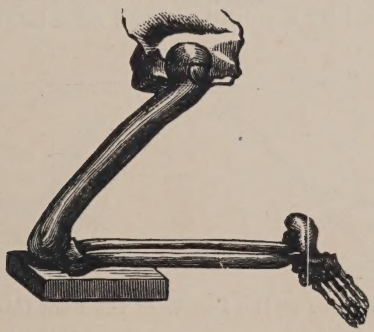


Fig. 2.—Showing Ball and Socket and Hinge Joints.

the arch of the foot when it is set down in walking, or when we lean our weight upon it in standing. Hinge joints form another division of the movable joints, and are seen in the foot at two of the joints of each toe. As the name implies, the action is backward and forward, as in a hinge. The most important joint of the foot is possibly the ankle joint, which, in part, has already been referred to. By the action of this joint the foot may be brought to a line continuous with that of the leg, and, again, by its action, the toes may be pointed to the ground. These are the actions of flexion and extension respectively.

There is a movement possible between the astragalus and the calcanenum. This allows of the foot being turned inwards or outwards. In many respects the mechanism of the foot is similar to that of the hand—yet in its actual working it is very dissimilar. For instance, though the mechanism of the foot is the same from below the knee joint as is the hand below the

elbow, yet as we do not need to have the foot turned with its sole downward and upwards (as the palm can be turned), so the joints of the lower arm differ from those of the lower leg. There is no rotating movement of the lower leg as in the lower arm. This, however, gives greater strength to the lower limb in supporting the weight of the body, and thus the balance of usefulness is maintained.

At the juncture of the foot with the bones of the leg, a joint of the ball and socket order is seen. Of the perfect ball socket joint only two examples are to be seen in man; the shoulder and the hip. That at the ankle is of an intermediate character. The true ball and socket joint is formed by a rounded head of a bone fitting into

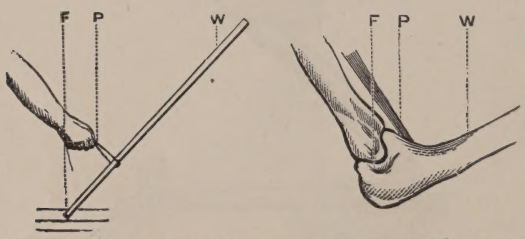



Fig. 3.—Explanatory of the Levers of the Foot (Morrant Baker).

a hollow cup. Thus the bone with the rounded head is enabled to move in any direction whatever, unless checked. The joint at the juncture of the foot and leg being, however, of an imperfect character, and resembling a hinge joint somewhat as well, although able to move in a number of directions, is not capable of such free, unrestrained motion as the bone of the arm fitting the shoulder. At the great toe we have also a limited ball and socket joint. It is situated at the root of the toe.

At this point it may well be mentioned that, in joints in which free and extensive movements take place it is necessary to have some means of preventing the injurious effects of friction. This is provided for in the joints of the foot by the employment of secreting membranes, called the bursœ mucosœ. Such a membrane is situated and attached in the following manner:—A piece of cartilage, fixed to each bone, grows in a circular manner; thus, on either bone a raised ring is developed. Now, growing from these rings of cartilage, and joining them, is the secreting synovial membrane, forming thus a kind of loose bag between the joint.

Secreted from this membrane is an oily fluid, called "synovia."* It is in this bag-like membrane that the fluid is thus held between the joint to lubricate it. Synovia is only formed as needed, the supply being regulated by the demand. If the joint is used much it does not wear out, but becomes the more healthy; if, from any cause, the use of the joint is restricted, then by the consequent non-secretion of the lubricant it speedily becomes set and dry.

This brings us to the consideration of the fleshy matter of the foot. The bones alone would be useless for the purposes of locomotion. The purpose of bone in the animal economy is purely mechanical, the muscles being

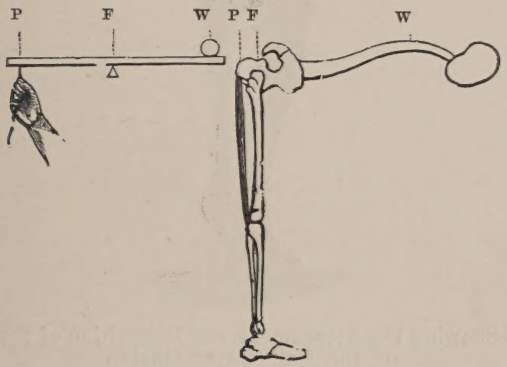



Fig. 4.—The Levers of the Trunk.

the active means of motion, the bones serving as points of attachment to the muscles, in the midst of which they are situated. Muscle is the chief fleshy matter of the foot and leg which demands our attention here. It is of that, accordingly, which we shall now treat.

The great peculiarity of muscle is its power to alter the nature of its dimensions. It is by means of this power that locomotion is accomplished. When a muscle contracts—that is, shortens its length and increases its bulk—it tends to bring its two ends, and whatever is thereto attached, together. The calf contracts, "acts upon the foot as a lever of the second order,† thrusts the

*Meaning like the white of an egg; synovia containing an abundance of albumen, of which the white of egg is a good type.

† "If the fulcrum be at one end, and the weight be between it and the power, so that the weight and power describe concentric arches, the weight moving through the less space when the lever

body upwards and forward,"* and the step is taken. Voluntary muscles† of their own accord have not the power to contract—that is, without the impulse of the will—and only do so by the change which takes place in the nerve distributed to them. This nerve, receiving its impression from the nerve centre, transmits the order to

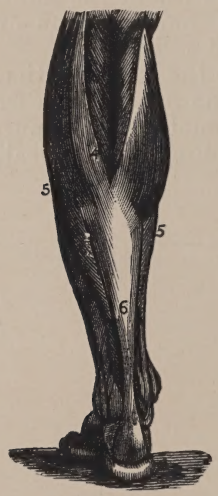



Fig. 5.—Showing the Attachment and Disposition of the Muscles of the Calf (after Quain).

the muscle; thus, truly, all motion is from the brain primarily, and secondarily from the muscles.

The movements of extension and of flexion are mainly effected by three muscles:—

(a) The muscles of the calf attached above to the bones of the thigh and leg, and below to the calcaneum.

---

moves, the lever is said to be of the second order. If the fulcrum be placed between the power and the weight, so that, when the power sets the lever in motion the weight and power describe arcs, the concavities of which are turned towards one another, the lever is said to be of the first order (Fig. 4). If the fulcrum, being still at one end, the power being between the weight and it, so that, as in the former case, the power and weight describe concentric arcs, but the power moves through the less space, the lever is of the third order (Fig. 3)."—Huxley. Elem. Phys., c. 7, sec. 6.

* T. H. Huxley.

† Muscle is of two kinds—voluntary and involuntary. The voluntary muscles are treated of in this chapter.

(b) By a muscle* attached above to the larger bone of the lower leg, and below by its tendon to scaphoid bone.

(c) By a muscle† attached above to the smaller bone of the lower leg, and below by its tendon to the outermost metatarsal.

The first of these muscles raises the heel, the second turns round the inner, and the third the outer ankle. The raising of the toes, the turning of the foot outward, and the straightening of the sole are accomplished by two muscles,‡ the tendons of which pass, one in front of the inner ankle, and the other in front of the outer ankle, and are inserted respectively in the internal cuneiform and outer metatarsal bones.

Fig. 6.—The action of walking, showing how the curve is rendered more acute at the back, above the heel, when the heel is raised above the ground.—Kirkes.

Of fleshy matter other than muscle in the foot, the padding of fat is the principal constituent. It is this padding of fat that gives roundness and symmetry to the form of the foot. The skin which envelops the bones and fleshy matter now remains to be dealt with.

This integument has two distinct parts—a thin outer layer called the epidermis, or scarf skin, and a deeper part sometimes called the dermis.§ The scarf skin is not sensitive to injury, but acts as a protection to the true skin, which is very sensitive and tender. Professor Huxley gives a very excellent illustration of the relation of the epidermis to the dermis. He mentions that, in shaving, the epidermis alone is passed over by the razor, thus causing no pain or inconvenience; but if the razor reaches the dermis, then blood flows and pain

---

* The posterior tibial.
† The short fibular.
‡ The anterior tibial, and the third fibular.
§ Epidermis is sometimes called the cuticle, and the dermis the cutis vera. The terms above used are, however, more general.

ensues. This outer skin, then, speaking in the general sense, is destitute of feeling. It is this epidermis which rises to a blister when a part is injured, and which thickens itself into hard places when pressure is put upon it in one particular spot. Indeed, those outer parts which naturally are subject to most friction and wear, such as the sole of the foot, are always much thicker than where less friction is likely to occur. Yet still, as Nature can make strenuous efforts to accommodate herself, even in unhealthy surroundings, if pressure occurs, where naturally the skin is thinnest,

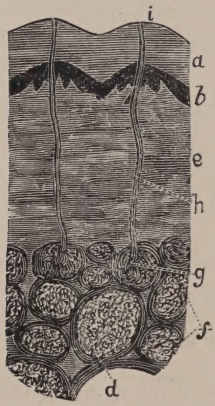



Fig. 7.—A Section of the Skin, highly magnified.

Showing (a) the epidermis, or scarf skin; (b) its deeper layer; (c, d) the dermis, or true skin; (f) fat cells; (g) the coiled end of a sweat gland; (h) its duct; (i) its opening in the surface of the epidermis.—Huxley.

tougher and more resisting layers are speedily developed to meet the demands of the extra strain.

The skin of the foot is very tough and strong; between it and the bones is the plantar fascia.

Beneath the scarf skin, as has been before observed, is the true skin. This is full of vessels, nerves, and the organ of touch. The proper action of these parts being of importance to the health of the entire organism, and of themselves being very tender, the wisdom of the use of the scarf skin, and its power of accommodation for the protection of the true skin, are clearly seen.

The formation of the foot itself tends to the preservation in health of its various parts. Thus the arch of the

inside waist is so designed that pressure shall not devolve upon the important nerves and blood vessels plentiful at that part, and the lesson is plainly indicated that the footgear should not be so formed as to press at this point, but should be covered by a material as little rigid as possible, and of as pliable a character as the conditions will permit. The pain of flat foot is solely caused by such pressure produced, in such a case, by the falling of the bones forming the arch, generally by the slipping of the astragalus out of its normal position upon the calcaneum.

---

## QUESTIONS FOR CHAPTER I.

1.—Give the divisions into which the bones of the foot most naturally fall.

2.—Name the three most important joints of the foot, and say where they are located.

3.—By the agency of what muscles is the foot "extended"?

4.—By the agency of what muscles is the foot "flexed"?

5.—Describe briefly the structure of the skin of the foot.

## CHAPTER II.

### Geometrical Preliminaries.

A KNOWLEDGE of geometry is becoming more and more essential to workmen of almost every trade, and, on account of its practical utility, it is one of the most attractive of studies. Its applicability to the boot and shoe manufacture has been more than once demonstrated, especially with regard to upper patterns; indeed, to understand properly the best methods upon which upper patterns are got out and graded, it is necessary to possess a knowledge of geometrical proportion.

Geometry is a branch of the science of mathematics which treats of magnitude, and is divided into Theoretical and Practical. Theoretical Geometry proves the principles of the science, while Practical Geometry applies those principles to construction. Practical Geometry is sub-divided into two branches—Plane and Solid. Plane Geometry describes the construction and properties of lines and figures, whilst Solid Geometry treats of the delineation of solid bodies upon plane surfaces. For the present it will only be necessary to deal with the application of Plane Geometry.

**A Point** has neither length, breadth, nor thickness. It merely denotes a position, and is shown in drawings thus— .

**A Straight Line** has length, but not breadth nor thickness. It is the shortest, or nearest, distance between two given points.

**An Angle** is the inclination to each other of two straight lines meeting in a point.

**A Right Angle.**—When one straight line, meeting another straight line, makes the angles on either side of it equal to one another, each of these angles is a right angle. In such a case, the lines are said to be mutually perpendicular.

**An Acute Angle** is an angle smaller than a right angle.

**An Obtuse Angle** is an angle that is greater than a right angle.

**A Triangle** is a figure enclosed by three straight lines. When these lines are of equal length, the triangle is called equilateral. When two of them only are equal, it is an Isosceles triangle. When the lines, or sides, as they are called, are all of unequal length, then the triangle is called Scalene.

**A Right-Angled Triangle** has one of its angles a right-angle.

**A Quadrilateral Figure** is enclosed by four straight lines.

**A Square** is a quadrilateral figure having all its sides equal, and all its angles right angles.

**A Rectangle** has two pairs of equal sides, and all its angles are right angles.

**A Parallelogram** is a figure having two pairs of equal sides.

**The Diagonal** of a straight-lined figure, such as a rectangle, is the line which joins two opposite angular points.

**A Polygon** is a figure having many sides.

**A Circle** is a space enclosed by a line which is at all parts equally distant from a fixed point, which is called the centre. The circumference or boundary line is also called a circle.

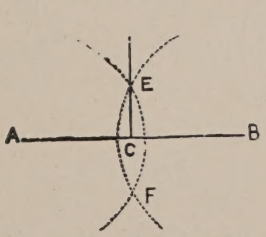
**A Diameter** of a circle is a straight line passing through the centre and meeting the circumference in two points.

**A Radius** is half a diameter.

**An Arc** is any part of the circumference of a circle.

In order to properly progress with the subsequent problems, a few elementary problems have been set which the student should first work.

PROB. I.—To bisect, or divide into two, a given straight line. Let A B be the given straight line. With



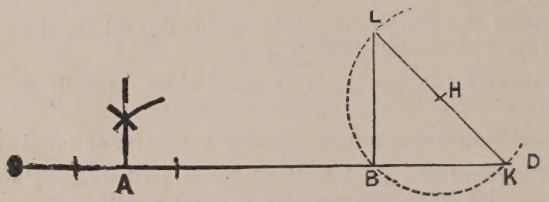

Problem 1.

A and B in turn as centres, with a pair of compasses having a radius larger than half the line, describe arcs intersecting E and F. Join E F. Then the point C, where E F meets A B, is the centre of the line. By ex-

tending this process, and bisecting each half again, the line can be divided into four equal parts, and so on.

PROB. II.—At the given points A and B in the given straight line C D, to erect perpendiculars, and make right angles.

On either side of the point A mark off equal distances,



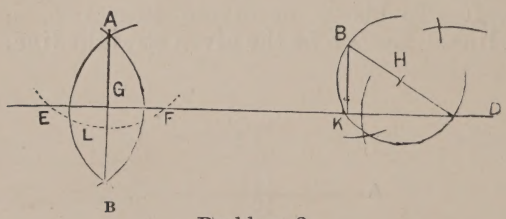

Problem 2.

and from the intersections of the arcs, with the line as centres, describe other intersecting arcs.

Another construction is shown in the case of the point B. Take any point, H (off the line), as centre, and describe an arc K B L, passing through the point B and the line C D, in K; join K H, and produce it beyond H until it meets the arc in L. Join L B.

PROB. III.—Through the points A B, to draw lines perpendicular to C D.

Here, again, there are two solutions. (I.) With A as centre, draw an arc E L F, which will cut C D in two




Problem 3.

points, E and F. Bisect E F in the point G. Then a line joining A G is the required perpendicular. (II.) Draw any line B T, intersecting C D in T. Bisect B T, and, with H as centre—radius H B—describe the arc B K T, intersecting C D in K. Join B K.

At the bottom of all methods of pattern grading by geometric methods is the theory of geometrical propor-

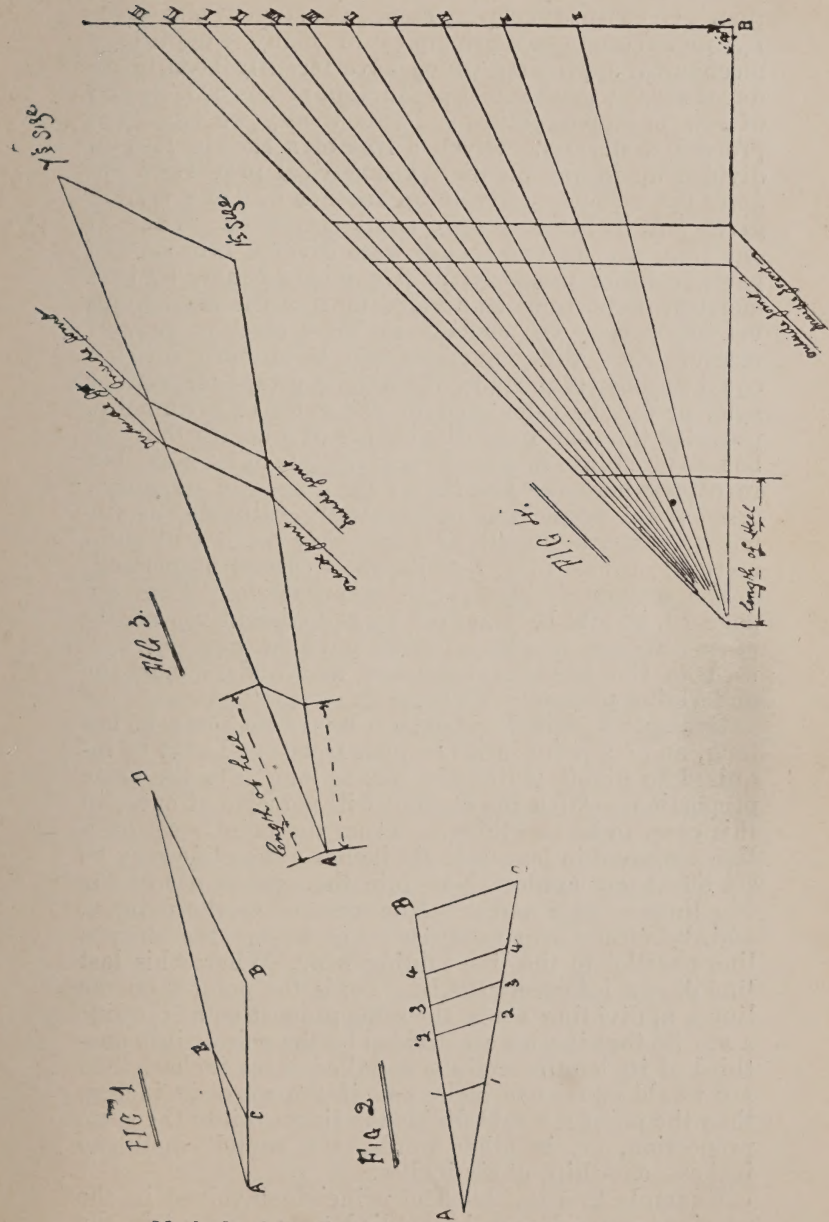


FIG 1
FIG 2
FIG 3.
FIG 4.
Length of heel
Length of heel
Length of heel

tion. Once this theory is grasped the student may readily understand the principles of many complicated mechanical appliances which have recently been introduced for the mechanical production of sets of lasts and of sets of upper patterns. This theory we shall not proceed to discuss. Given a line of a certain length, divided up in any manner, geometrical proportion enables the student to divide up another line of a certain given length in an exactly similar manner. Thus, if one line, say, of two inches were divided into sixteen parts, another line, say, of five inches could, by geometrical proportion, be divided up into the same number of parts. Of course, in most cases of regular measurement, different lines can be divided into an equal number of parts by the help of a tape measure or rule, or can be calculated by the rules of arithmetic, provided the lines to be divided are of a length that can be measured into inches or regular parts of an inch; but in cases where the lengths of the lines are irregular, geometrical proportion is essentially valuable, as, no matter what the length of a line may be, it will automatically divide it up into the most correct proportion.

The examples, illustrative of proportion, given on page 13, should be practised by the student repeatedly upon different lengths of lines until he becomes well used to the methods employed and understands the underlying principles:—

Example I, Fig 1.—Let A B be a line three inches long, and C a point in it one inch from A. Let it be required to divide a line six inches long into the same proportion—which the student will perceive at once, in this case, to be one-third. From the point A set off a line A D equal in length to six inches. The line may be set off at any angle. Now join the extremities of the two lines as at B and D. Now proceed to the point C, and, by means of parallel rulers or set-squares, draw a line parallel to the line joining B D. Where this last line drawn intersects the line A D is the point E on the line A D, dividing A D in the same proportion as the line A B. So that if A B were divided by the point C into one-third of its length and A B equalled three inches, then A C would equal one inch; and if A D were six inches, then the point E would divide the line A D into the same proportion, or, in other words, A E would equal two inches—one-third of six inches.

Example 2, Fig. 2.—The principle involved in the previous example can be applied to any extent in the

proportionate division of lines. Fig. 2 shows a further application. Draw A B, a line of any length, and place anywhere upon this line four points, as 1, 2, 3, 4. Draw a line A C from point A, at any angle of convenience. Connect the two extremities of the lines by the line B C. Parallel to this line draw other lines from the points 1, 2, 3, 4. Where these parallel lines intersect the line A C, as in points 1, 2, 3, 4, it will be found that the line A C will be divided into the same proportion as the line A B.

Some practical examples of the applications of these theories will now be given.

Example 3, Fig. 3.—If the student properly comprehends the two previous examples, he will be in a position to understand that what follows is a practical application of the principle to the requirements of the boot trade. Draw a line A B (Fig. 3) equal to the length of a 7's last pattern; mark upon it the distance of the inside joint from the end of the toe.* Now, supposing that the student wished to get the distance of the inside joint upon a 1's size. In the first place he would set off a line from A, equal in length to a 1's size, join the extremities, and, parallel to this connecting line, draw another line from the point marked for the inside joint to cut the 1's length. The point where this intersected would be the point where the inside joint should be on a 1's. The same process can be repeated to get the positions of the outside joint and the length of heel, as has been done in the figure given.

Example 4, Fig 4.—This is the last and most complete example given of the application of the rule of proportion in the getting out of single sole patterns.

It is of importance for the proper progression of the student that this problem should be well comprehended and practised, for if the student thoroughly understands the examples given here, and is able to answer the questions given at the end of this chapter, he will be in a position to apply the principle as he thinks fit, and will easily comprehend geometrical grading when he gets in the Honours course. Referring to Example 4. It is presumed that the student wishes to get, by a single diagram, the positions of the joints and length of heel of each of the complete set of sizes, from boys' to 12's

* Mr. Hannibal gave these distances for the inside joint 1¾in. from a line dividing the length into two. For the outside joint 1in. above such centre line.

men's. In the first place, he has already, by means of the previous problem, got out the positions of the various points upon 1's size, from the given standard on a 7's size. He will now proceed to draw a horizontal line, A B, equal in length to a 1's size. From the end of this he must set up a line, B C, at a right angle (90 degrees), as per figure. From the point A mark off lines equal in length to the increasing sizes, the other end of each line to meet the upright or vertical line. This can easily be done by means of the tape measure. Place the end of the tape measure upon the point A, stretch it tight, and mark, by means of a pencil or awl, points upon the vertical line equal in length to the increasing sizes, keeping one end of the tape measure all the while upon the point A. Join all these points with A, as per figure. Now mark upon the horizontal line A B (which is equal in length to 1's size) the points representing the inside and outside joints and the length of heel. Draw lines parallel to the line B xii.; where the lines intersect the length lines of the various sizes they are divided in the points required.

If the diagram has been correctly drawn, the student has now by him a correct standard scale of the length of heel and position of the joints of all the set of sizes that will aid him materially in the getting out of any single pattern. He has but to take off the scale, by means of his measure or compass, the distance from the point A along the length line of any particular size required.

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## EXERCISE FOR CHAPTER II.

Construct a table of joint positions for sizes 1 to 10 from the data given at footnote, page 15.

NOTE.—If the student wishes to further pursue the subject of geometry on his own account he cannot do better than procure the elementary edition of Angell's "Practical Plane and Solid Geometry," published by Collins and Co., London and Glasgow, at 1s. 6d.

## CHAPTER III.

### On Measurement.

Authorities:—Northampton Technological Handbook on "Measurement," and especially Mr. Tebbutt's pamphlet in the same series.

A PROPER system of foot measurement is the sine qua non for success in any description of bespoke work, and, as under present methods of business the person who fits the last is rarely he who took the measure, it is of the greatest importance in all bespoke work that among all concerned in its production there should be a uniform conception as to what is the proper system. By this means alone can any degree of success be reasonably hoped for. So various are the opinions held as to which are the proper points for measurement that, in the multiplicity of doctrines, there is a great danger of confusion of ideas, with the inevitable production of an ill-fitting boot. It is not so much of importance where the measurement is taken as to how it is taken. Let us explain. Perhaps one holds the opinion that the joint measure should be taken at the widest part of the foot, even supposing that part to be in an angular direction; whilst another has the idea that the joint measurement should be invariably taken straight across the ball of the foot. Now, neither of these ideas is necessarily wrong, but when opposite opinions such as these are held and practised by two persons concerned in the production of one order, they are fatal. On the other hand, if some method were practised in connection with the system, denoting the exact distance either from the heel or toe that the measure is taken, it is then a matter of small consequence whether the measure is taken straight or slanting.

There is an idea, which has been taken from an American authority, that embodies this principle. The writer we follow recommends that the measurements,

being any number, should be taken straight across, and at a regulated distance from the toe, for, as he truly says: "We must indicate how far up the measure is taken to have any exact value in the measurement, the truest rule being to take all the measurs at certain fixed distances from the heel, these distances being regulated by the length of the foot." But, as he further adds, "correct measures do not always ensure a correct fit." He accordingly goes on to explain that the pitch of the boot should be regulated by an angle. Thus, "starting on the theory that in a boot without any heel the leg is at a right angle with the foot, the leg of the pattern for such boot must be thrown back from this line, according to the height of the heel, inch for inch, or fraction for fraction, in proportion."

A Spanish author has compiled a table based on this principle, having as factors the height, the amount of the spring, and the height of heel the last will carry.*

In order to obtain exact data for the correct formation of boots and shoes, and especially for experimental purposes and the collection of reliable statistics bearing upon foot dimensions, the employment of an apparatus constructed on the following method is suggested:—

On a flat base board construct a perpendicular at one end, upon which a rest shall slide, the slide to be so constructed that the heel may be rested on it. At the base, let a scale of lengths be marked, and a slide be placed, as on the ordinary size stick, to register the length, and let the whole apparatus be constructed of sufficient strength to bear the weight of a person. To ascertain the length let the client stand upon the size stick without resting the heel upon the back projection. To obtain the pitch, let the foot be placed on the back projection, which should be previously raised to the height of the heel required. Place a drawing board, on which has been fastened a plain sheet of paper, against the side of the foot; draw with a pencil on the board round the foot and leg, and this will give the elevation; now place a sheet of paper under the foot, and describe round the sole. By this means you obtain a plan of the foot.†

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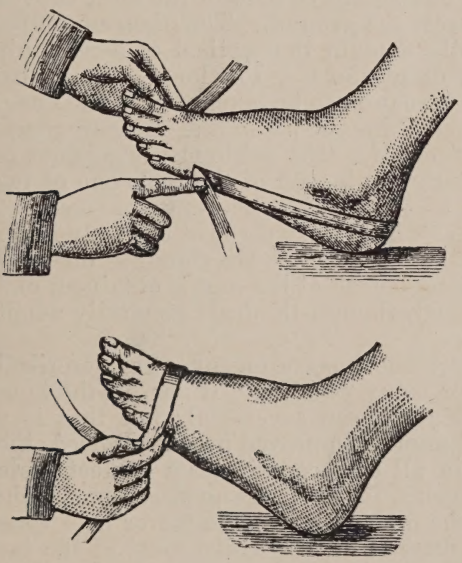
* Jose Gonzalo.

† Mr. Cremer, of New Bond-street, has an apparatus of this order, but which is for orthopædic work. The customer here stands, and numerous little platforms are raised by means of racks till they exactly fit the inclination of the foot. The apparatus is very ingenious.

Dr. Ellis has described a method for obtaining what he considers a correct delineation of the foot for boot-making purposes. His method would appear to be useful only in cases where time can be afforded.

The usual method of measurement does not necessitate the use of any apparatus beyond a size stick. By some makers the girth measurements are taken by means of the inch tape, but a strip of paper doubled over



An Improved Method of Measurement.

is by far preferable, and for this reason: With a tape measure it is necessary to express the measurements in figures, and it is hardly necessary to say that, if correctness is aimed at, the use of fractions is imperative, and these fractions are not always of the simplest nature. With the paper measure the dimensions are exactly registered by simply tearing the paper slightly with the thumb-nail. To avoid confusion with the joint and ankle measurements, it is necessary to register the dimensions of the ankle on the under side, together with the leg measurements, all the others being duly marked on the upper edge.

The joints usually measured for ordinary work are the joints, instep, heel, ankle, and leg. Some prefer to take two joint measures—the first joints' measure at the toes and the second at the joints proper. The measurement should be taken round the joint of the great toe and straight across, unless the foot be traced, when it may be taken in an angular direction.

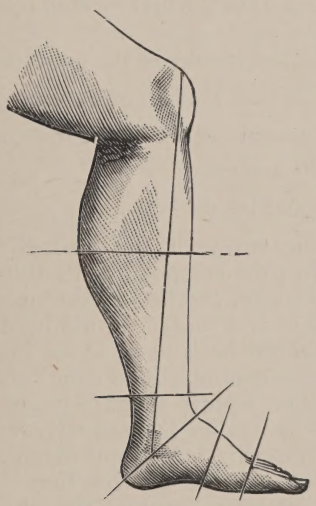
The heel dimensions should be ascertained with great care; the foot should not be lifted too high during the process, but should be held in the most convenient position nearest the ground. The diagram on page 19 will sufficiently explain the method of ascertaining the remaining dimensions. For long work additional measurements require to be taken—from the knee cap to the ankle bone, the calf, and the measurement from the back of the calf. The ankle measure is not required.

In taking the length of the foot, one of two methods may be adopted: The foot may be measured off the ground, or whilst the weight of the body is borne by the foot on the size stick. By standing on the size stick, the greatest length of the foot is obtained, and probably this method, though the least generally adopted, is the safest.

The system of measurement so far described has been in use for many years, and it has, in the hands of skilful workmen, been successful; but that is not to say that it cannot be improved upon. Indeed, theoretically it fails in all that constitutes a perfect system of foot measurement, for it makes no provision for the registration of the distance from the toe or heel where each of the measures is taken; whilst most of the faults which have been found with the system are clearly traceable to the neglect of this first principle. For instance, how many an order has been spoiled, not because the instep measure was incorrect, but because the dimension has been placed too forward? Such a frequent error can only be effectually avoided by the embodiment of the first principle in the system of measurement used. The principle can be, and has been, employed in a variety of fashions, but we do not know of a better system founded on the principle referred to, nor a more generally practicable one, than that which it will be our endeavour to describe in the following paragraphs.

Take a stout strip of paper, about twenty inches long, taper off at one end to indicate the starting point of the measure. In measuring the foot, first pass the strip of paper round the heel, and with the tapered end on the

inside of the foot. Let the strip be placed at the spot it is desired to measure for the joints in the following manner:—Place the tapered end at the desired spot first. Next notice the equivalent position on the outside of the foot, and at this point let the strip be firmly creased at right angles with the upper edge. During the creasing process the strip must be kept in exactly the first position. This will be rather hard of attainment at first, but with practice it will be found to present no difficulty. The strip creased, the third process is to ascertain the girth measurement of the joints at this distance



from the heel. To accomplish this the tape must be held firm to the inside of the foot. At the creased portion the tapered end must be brought off the foot and carried round to meet the stationary point; the tape in this process being used as under the ordinary system. Where the strip, when pulled firmly round, first touches the stationary point, it should be slightly torn with the thumb-nail. Thus will be indicated on the tape the girth measurement of the joints, and the distance from the heel that such measurement has been taken. It may be here remarked that, in taking the joint measure under this system, it is necessary that the tape be passed round the foot in a straight line, and not in an angular position. The instep measurements should be two in number. The strip should be passed round the heel

and a stationary point* indicated at the lowest extremity of the instep. The girth measurement should then be taken as for the joints. The process should be repeated for the centre of the instep, and the heel measure be taken in the ordinary manner, as likewise should be the ankle and leg measures. Thus, then, by the system here explained, the order of the dimensions obtained is as follows:—

1. The distance from the heel of the joint measure.
2. The girth measurement of the joints.
3. The distance from the heel of the lowest extremity of the instep.
4. The girth measurement of the lower instep.
5. The distance from the heel of the centre instep.
6. The girth measure of the centre instep.
7. The heel dimensions.
8. The ankle and leg dimensions.

The points of measurement on the last can now with certainty be made to correspond with those of the foot itself by a repetition on the last of the processes used in the measurement of the foot. In all bespoke work the sole of the foot should be traced, or an impression of it be obtained by some means. The usual method adopted is to place the foot on a plain sheet of paper and to pencil around it. This operation is generally very carelessly conducted, and from this fact is not often a trustworthy guide as to the character of the foot. The tracing of the foot is of little use unless the character of the waist is indicated on the tracing, yet, strange to relate, in the majority of instances this indication is altogether neglected. In order to secure the best results in this direction it is recommended to use a different method to that of pencilling round the foot.

In the "Deutsche Schuh-Industrie Zeitung," a few years back, a method was described which has been found in practice to be productive of good results. It is as follows:—Take a solution of any aniline dye, and with a brush lay it carefully on one side of a sheet of ordinary writing paper and let it dry. Now, to obtain

* A stationary point is to be understood as the point on the tape registering the half distance from the heel, i.e., where the strip is creased and held stationary.

the impression, lay the paper with the coloured side downwards upon damp cardboard or millboard of soft texture; let the foot to be measured be placed upon it, then trace carefully round the foot with a pencil, so as to obtain the outline also; and on the foot being raised you have the impression and outline to the fullest advantage.

Another method for securing accurate location of the measurements is to first trace the foot in the stationary position, and whilst in that position to take girth measurement, located by straight lines traversing the plane horizontally. Under these circumstances it is necessary —or, at least, desirable—to use a tape measure. Where a measure is taken a line should be drawn across the plan, and the exact amount of the measurement marked at the termination of line.

Since the first edition of this Manual this method has been improved upon, and a fresh and better mode for obtaining an impression of the sole of the foot has been given by the author of the first Northampton Technological Hand-book. The proposal there given is for the use of a transfer sheet soaked in a preparation of an aniline colour with glycerine and alcohol.*

Each age develops its own needs, and the age that has made a specialist no less of the distributor of boots and shoes than of the manufacturer of them has created the need for an adequate mode of expressing the facts of the foot's form and characteristics, in addition to the symbolism of figures and words already available. Of necessity, this mode must be of a pictorial character, for the boundaries of the form and not the nature of the form itself is all that is expressible by figures and words. Where the distributor is dissociated from the producer, as is usual in these days even in bespoke shops, there is always more or less difficulty in describing to the last fitter or the manufacturer the exact form of the foot to be fitted.

It has long been known that dimensions of sizes are

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* The author we quote does not give the exact formula. Knowing the need students feel for exact information on these matters, I have ventured to give the quantities and the dye I have found to produce a good result:—

Aniline Black, 5 grains.
Alcohol, ½oz.
Glycerine to make 2oz.

For other methods and further information see the handbook referred to.

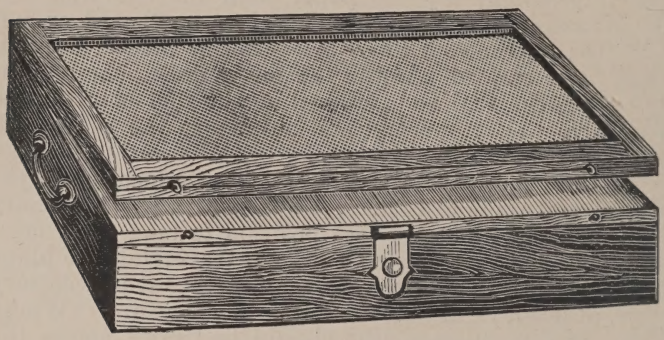

Fig. 1.

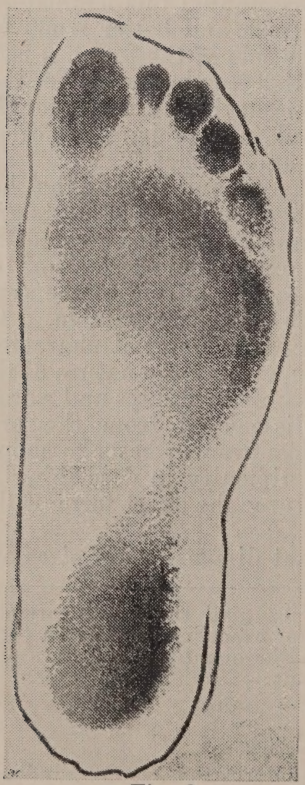

Fig. 2.

Fig. 3.

but of comparative value for the production of perfect-fitting boots and shoes. Exact methods for the measurement of the external dimensions of the foot, and for the recording of such dimensions, are already available, but an adequate method of recording the form of the foot cannot be said to be so general. If a true indication of the character of the bottom of the foot be recorded by means which admit of its ready transmission, its value would be undoubted. There are already rough means resorted to for this purpose, but to be of real value they are not accurate enough. Tracings or impressions of the soles of the feet, to be of real worth and practicability, ought (1) to be of such a character as to admit of their ready and cleanly use; they ought to (2) indicate the degree of the arch of the foot, and (3) the exact amount of the sole of the foot that rests upon the ground. To simply trace round the edge of the foot by means of a pencil, even though that pencil be flattened, may be a ready method, and may fulfil our first condition, but does not fulfil the second or third. Mere pencilling the sole gives the boundaries of the upper edge of the foot, but not of the real sole width. This method may, however, be so conducted as to give an indication of the character of the foot, and is so conducted when the pencil marking is continued under the waist as far as it will go, and information is thus recorded that, in the hand of an experienced last fitter, may be of great service.

The only method whereby the extent of the sole touching the ground may be indicated is, however, by means of an impression. Just a word may here be said on the use of tracings to the last fitter. But little experience alone of tracings need be had before it is apparent that the ordinary pencil tracing is useless for the purpose of indicating the bottom width that should be given to the boot. What is wanted is some means whereby the exact width of the inner sole may be indicated. The edge of the foot is of such a bevelled character that a mere pencil tracing can never indicate this. An impression, however, taken by proper means may give that which is required. A general objection, however, to all methods for taking impressions is that they are messy and cumbersome. All will admit that if a ready method for obtaining an impression be available, such would be the most useful aid that the last fitter could have.

Several methods for taking impressions, quite admirable in themselves, but mostly useless for the purpose of

the bespoke bootmaker—because too complicated—have been described—and have already been referred to—in the Northampton Technological Handbooks; and the method described by Dr. Ellis, admirable in its results, of smearing the foot with printer's ink, must, of course, be ruled entirely out of court. The method I am about to describe, however, is one which has long been in practice in Continental countries, and is a cleanly, ready and exact method for obtaining an impression of the sole of the foot, and the true extent of its bottom width.

The apparatus for the conduct of this method is pictured in Fig. 1, and consists simply of an inverted box, with a hinged frame as a lid. Clamped in this frame is stretched a sheet of indiarubber. When the lid is raised, a sheet of plain paper is placed upon the bottom of the inverted box. The indiarubber on its under side is lightly painted with ordinary endorsing ink of any colour, but preferably green. The apparatus being so prepared, the frame is closed down and fastened with a small catch. The customer then firmly and decidedly plants his foot upon the uninked and upper side of the rubber. The foot being in such a position, the whole weight of the body is borne upon it, and the outline is marked around with a piece of thin bevelled wood, and an impression is obtained such as is figured in Fig. 2. It is not absolutely necessary, and mostly not desirable, to mark round the outline with a piece of wood as now described, and in that case we get a result such as is given in Fig. 3. It should be said that Figs. 2 and 3 are reproductions of actual impressions taken on the appliance described.

By means of these tracings, one can instantly see the amount of the bottom width and the exact shape and size of insole. The length, of course, will not be indicated, for the simple reason that a large part of the length of the great toe itself does not touch the ground. The amount of this length of the great toe not touching the ground gives an indication of the amount of natural spring in the foot itself, and indicates exactly the point from which, in the foot traced, the spring commences, and thus the impression serves an additional purpose. It indicates as well the amount of the longitudinal arch, and of the tranverse arch, giving, in these two particulars, facts under existing methods of foot measurement left unrecorded and even unindicated. Beyond all, the method is ready, simple, and cleanly; the charts are

easily preserved, are of excellent service to a last maker, and can be sent through the post. The apparatus is easily and cheaply made, and for the good service to which it may be put ought to be used by every boot-maker. So highly, indeed, do some of the Continental manufacturers value the services of the charts obtained by the appliance to themselves, that they make the use of it a condition of the manufacture of a customer's specials, and send him on the appliance, and invoice it to the customer, usually at one guinea.

We have now to consider the question of lengths and fittings; but before doing so it is well that we should have some clear conception as to the extent to which it is allowable to adopt the system of regular gradation; that is to say, how far it is a fulfilment of the conditions desirable of embodiment to produce certain larger fittings from smaller fittings, by simply adding an even amount in even places to produce a larger fitting. According to the rules of true proportion, of course, such method is quite out of the question. We are not disposed to quarrel with the mode, however, because of its non-compliance with that theory, simply because that theory in practice is not itself found faultless. The most intelligent of the last makers using the last turning machine for last production, which works on the principle of true proportion, find the method best applied by grading either side of an average model, that is to say, grading up and down, thus minimising the faults which would result from a long grading upward from a small size last. It is not, therefore, because of the want of accordance between this practice of fixed addition with the proportional theory that the method is to be condemned. It is simply because of its non-consideration of the many other matters which are intimately concerned in the production of varied fittings. Mere regular gradations of the circumference of lasts are not sufficient to produce a four fitting from a one fitting, least of all is it allowable to produce a six fitting from such a basis. We may safely say that different fittings are necessitated from several causes. A person who takes a narrow fitting at one time of life, at a later period will probably require a fitting larger at some parts as age increases. Therefore, the question of age enters largely into the consideration of what shall constitute a fitting for such a person. Deformities peculiar to a certain age are also a determinative influence. As age increases we have said the necessity for a

four fitting is found by some people to whom a two fitting was desirable in early life. Why? Probably atrophy of the ligaments of the foot causes a depression of the instep and enlargement of the joints. If the system of regular gradation or of proportional gradation were adhered to, the four fitting under such circumstances would be too large at the instep and heel and too small at the joint. The nature of the footgear it is intended to construct on the last has also to be thought of. A set of lasts on which it is intended to construct Wurtenmburg heel work requires a different treatment in the grading to that of a set of lasts of a hygienic shape. Particular shapes of boots render the foot susceptible to pressure in different places, and hence, further, the necessity for a more liberal grading at such a part than for lasts having no such tendency. A lady's riding boot and the last intended for it is a case in point. Many ladies are extremely sensitive to the pressure of a riding boot upon the higher instep. Special provision accordingly must be sought for this supersensitiveness caused by a particular form of footgear.

Either, then, cross fittings must be used in conjunction with the regular grading of fittings, such as Mr. Tebbutt or Mr. Brophy gives us, or new initial models for particular fittings must be designed, having full consideration given to the facts we have pointed out in their construction, and keep the regular gradings for the production of sizes in certain classes, but never (without cross fittings being supplemented) depending upon regular grading to produce one fitting from another.*

## QUESTIONS FOR CHAPTER III.

1.—What are the conditions for a perfect method of foot measurement?

2.—Give one or two methods embodying these principles.

3.—What difference in the measurement taken is there for long and short work?

4.—State how a satisfactory impression of the sole may be obtained.

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* For table of measurements the student is referred to Mr. Tebbutt's pamphlet and to Mr. Brophy's "Pattern Cutting Made Easy."

## CHAPTER IV.

### On Sole Shapes.

Authorities.—"Why the Shoe Pinches" (Prof. Meyer)—Camper's essay, the English translation of which is bound up with Dowie's "Foot and its Covering"—Ellis's book is most valuable—The rather incoherent chapter in Hannibal's "Last Fitting and Pattern Cutting" may be read as one of the earliest attempts at a scientific statement of the facts bearing upon sole shapes—For the historical part, J. S. Hall's "Book of the Feet" may be consulted.

In looking at the question of sole shapes from an historical point of view, we find that the farther we go back the nearer does the shape approach perfection in its regard for the comfort of, and its fidelity to the outline of, the foot. Perhaps the earliest type of foot protection of which we have any record is the ancient Egyptian sandal. Sandals were only made to protect the soles of the feet when travelling over rough surfaces. They were fastened to the feet by means of straps; and hence, there being no covering to speak of for the upper part of the foot, the toes could not in any way be cramped. The shape of the sandal, therefore, had to be in accordance with the outline of the foot. They were made of a hard material, usually wood, and were much curved in the forepart—given, to use a modern term, a great deal of "spring"—so as to assist progression.

The fastenings generally proceeded from between the great toe and the smaller ones, the waists on either side, and the back of the heel, meeting at the top of the instep, and there being fastened together. The drawback of the sandal consisted in its extreme rigidity, and it gradually gave way to the use of the skins of animals.

The sandal was only appropriate to a warm, dry climate; and later on we find the Roman sandal for travelling was provided with upper covering in such a manner as to protect the body of the foot and the lower part of the leg, though leaving the toes bare, the shape of the sole being still that of the foot.

The footgear of the early Saxons is a fair type to take of the later period. The foot was wrapped first in cloths to protect it from the cold, and then covered with a shoe made of one piece, shaped and fastened with a thong in such a manner as to fit the foot like a purse, somewhat resembling the moccasin of the North American Indian. This, while it did not distort the foot, and allowed every movement free play, was not of a sufficiently enduring character to find favour long with the wearers; and from this fact came the application and use of stouter pieces as soles. The shoes of the Saxon then began to be made of a peculiar and distinct fashion —the pointed toe. This pointed toe, however, was very different from the pointed toe as we understand it now. It did not cramp the toes, and so, in order to be pointed, it had to be made of greater length than the foot. It was the abuse of this fashion that produced the enormously long-toed boots of the Middle Ages. Fashions, though they repeat themselves and run their course into extremes, still change with the times; and so we have, following upon the fashion previously noticed, the immensely broad toes of the Eighth Henry. Since that time the shape of the sole has had many variations, the variations seeming to be greater where the countries are more civilised.

Of late years much attention has been drawn by the medical faculty to the natural requirements of the body; and as feet have been among the most tortured portions of the human frame, they have consequently been especially noticed by hygienic reformers. It is now beginning to be recognised that, whilst the details of the making of boots, and the materials of which they are made, may be changed and varied to suit the most fastidious and eccentric of Fashion's laws, there are certain natural requirements of the foot that must be rigidly adhered to, if the foot is to maintain a healthy, normal condition.

The sole should be of such a shape as to allow the toes to lie in their normal position. As the toes lie directly forward of the metatarsal bones, in the same line, the shape should allow of this natural rule being maintained. To do this, the shape of the sole pattern must be full wide forward of the inside line, and from the big toe joint to the end of the pattern be straight, instead of turning towards the outside. The outside joint should be full to prevent the little toe being cramped. The heel should be one-fourth the length of the foot, so that it

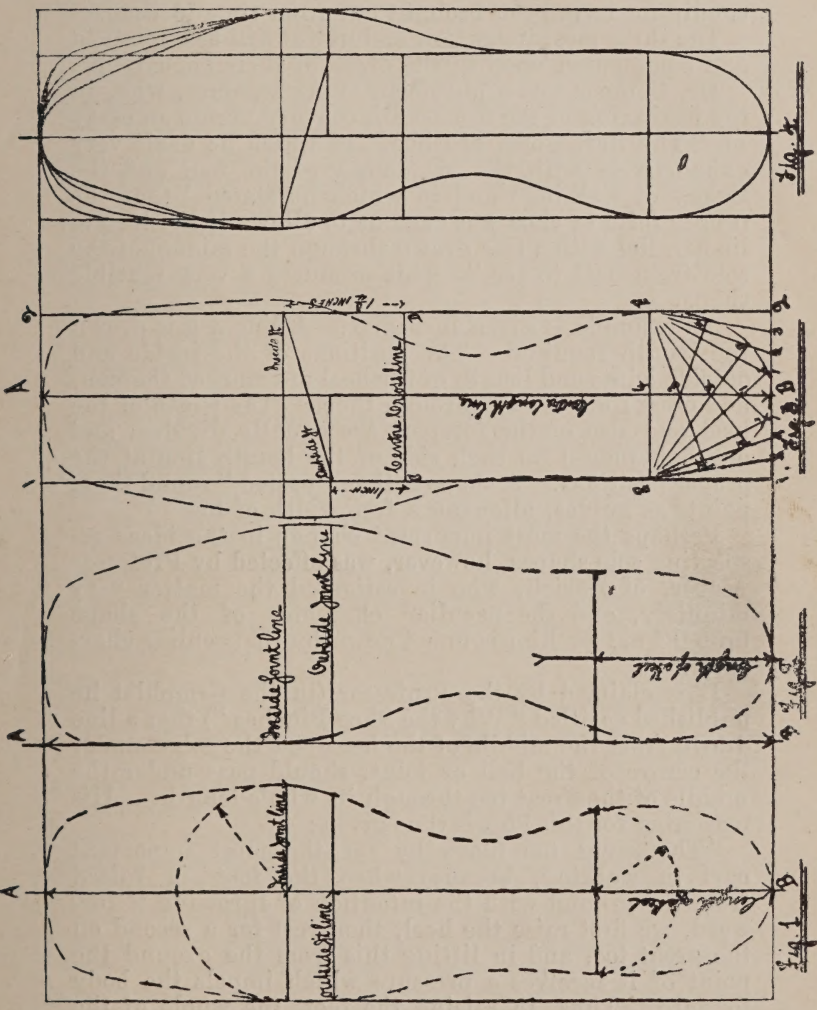
Fig. 1
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Fig. 17
Fig. 18
Fig. 19
Fig. 20
Fig.

may support the hinder piece of the arch of the instep; while the width of the heel and joint should be—in the inner sole pattern—nearly equal to that of the foot. Many systems of getting out sole shapes that fulfil these conditions have been brought out from time to time.

The three most important and useful will be explained and commented upon in the order of their appearance.

Dr. Camper was a physician of Amsterdam, who, in the beginning of the nineteenth century, wrote an essay on "The Best Form of Shoe," in which he dealt very exhaustively with the physiology of the foot and the theory of walking; and in which he stated "that the proper form of shoe was such as to allow all the toes to lie parallel with a line drawn through the middle of the sole from heel to toe." This produces a very sensible shape.

An example is given in Fig. 1.—A line A B is drawn the length required. The positions of the inside and outside joints and length of the heel are marked thereon, and cross lines drawn through them. The width of the heel and also of the forepart are equally divided, and one half placed on each side of the length line at the proper positions. A shape is then "casted" round these points as guides, allowing a free width of toe.

Perhaps the most important change in the ideas respecting sole shapes, however, was effected by Professor Meyer, of Zurich, who investigated the matter very minutely, and the peculiar character of the shape brought out by him is now known by its peculiar character.

It is claimed by the Professor (in the pamphlet he published entitled "Why the Shoe Pinches") that a line drawn from the middle of the heel—on the sole—under the centre of the ball or joint, should pass under the middle of the great toe through its whole length. His reasoning for this idea is thus given:—

"The great toe plays by far the most important part in walking, because when the foot is raised from the ground with the intention of throwing it forward, we first raise the heel, then rest for a second on the great toe, and in lifting this from the ground the point of it receives a pressure which impels the body forward. Thus, in raising the foot, the whole of the sole is gradually, as it were, unrolled up to the point of the great toe, which again receives an impetus by contact with the ground. The great toe, therefore, ought to have such a position as will admit of its being un-

rolled in the manner described; that is to say, it must so lie that the line of its axis, when carried backwards, will emerge at the centre of the heel; and this is its position in the healthy foot."

Fig. 2 gives an example of a shape got out upon this principle. A line A B is drawn equal to the length required. Upon this the positions of the joints are marked, also the length of heel; cross lines are drawn, upon which are marked the widths, and the sole shape is then cast out around the points found, taking care that the shape from the inside joint to the end of the foot should keep touch with the line A B. This is the readiest method of getting out a sole shape upon Dr. Meyer's principle, as boots made after Dr. Meyer's style always touch toe and heel. Indeed, it is this peculiarity that gives these boots their remarkably twisted appearance—an appearance which has to a great extent retarded their general adoption.

The next system of getting out sole shapes of which we shall treat is that of Mr. Hannibal.

His system is one which has found favour with all who have tested it, and is, perhaps, the most practical ever introduced; as, while any style of shape can be got out by its help, it also lends itself to the production of a hygienic shape with a sensible adaptability—a hygienic shape that answers all the ordinary requirements of the foot, at the same time having nothing that is either extreme, noticeable, or eccentric; and no matter what shape may be produced by the help of the system, if it be properly done it will always catch the principal, or what are called the tripod, bearings of the foot—viz., the inside and outside joints and the heel.

Fig. 3 is an example of this method, and the mode of procedure is as follows:—

Assuming that we have a 7's size to get out, and the necessary measurements—viz., width of heel and forepart—two lines are drawn, as 1, 1, 2, 2, equal to the length required and exactly the width of the heel. Another line is drawn dividing this rectangle, as at A B. This is called the centre length line of the pattern. A fourth line is drawn at right angles, as at C D called the centre cross line. Now, as the size we are getting out is a 7's, certain measurements have been fixed as standards in getting the positions of the inside and outside joints upon the parallel length lines. This is easily understood by reference to the diagram. The point of the inside joint is $1\frac{3}{4}$ inches above the centre cross line, that

of the outside 1 inch above.* Lines are now drawn at right angles through these points, as shown on Fig. 4. The next thing to do is to draw a line equal in length to the width of the forepart; upon this mark the width of the heel, and divide the difference of the two widths into four parts. This is done automatically by means of a separate diagram. One of these four parts is placed on the cross line at the inside joint, the other three parts being placed to the credit of the outside joint. Around these points a shape is constructed, care being taken not to cut inside the points found.

One of the best and readiest methods of getting out the shape of a heel is by an application of the properties of the ellipse. Measure off along the centre length line A B a distance equal to three-fourths the width of the heel, and draw a cross line, as E F. Now divide the distance marked B 4 into a number of equal parts, four being the easiest number; also divide the distances B 1 and B 2 into the same number of equal parts. Connect these divisions by straight lines with the points E and F. Now draw lines from E and F through the divisions in B 4, as per figure. Where these lines intersect the other lines as previously drawn, according to their number, they produce points which direct the curve that the heel is to take. Through these points draw the shape of the heel, and if the drawing is correctly done the diagram should result in a curve that is a good shape for the heel of the pattern. Once the student comprehends the working of this application he can apply it to different measurements and produce different shapes, although the dimensions here given for working may be taken as giving a reliable, all-round shape for the pattern, as regards the heel.

Fig. 4 shows various shapes of toes, got out upon Hannibal's system, as a guide to the student in designing a variety of shapes. It will be noticed that the centre length line is always in the centre of the toe, whatever the shape. It will be as well to mention, for the benefit of those students who may not have noticed the fact, that, though this centre length line passes through the centre of the toe-shape, the toe itself is not in the centre of the pattern, as the bulk of the difference

* Taking these measurements as standards, by using the means described in the chapter on Geometrical Preliminaries, the student can easily get out for himself a scale of the various distances of the joint points of all the other sizes.

between the widths of the heel and the forepart is placed on the inside point; and this is as it should be, as the great toe of the foot is on the inside. And whatever the shape of the toe of the pattern, when the shape departs from the standard fixed to accord with the requirements of the foot, whether it be medium, round, or very narrow and pointed, the great toe of the foot should not be displaced any more than can be helped.

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## EXERCISE AND QUESTIONS FOR CHAPTER IV.

1.—Write out Meyer's rule.

2.—Wherein does Camper's rule differ from Meyer's?

3.—Construct a 6 size men's insole to Meyer rule.

4.—Construct a 7 men's insole to the Camper rule.

## CHAPTER V.

### On the Primary Pattern.

Authorities:—Hannibal's "Last Fitting and Pattern Cutting" contains much that is valuable concerning the principles—Morris's book is suggestive but fanciful—The many essays of Mr. Swaysland contributed to the trade journals are the most helpful and reliable of anything written on this subject—Brophy's "Pattern Cutting Made Easy" may be read for "Grading"—Ward explains one or two current methods—There is also a suggestive book by Busch, of Erfurt, containing methods practised on the Continent.

PERHAPS no part of this Manual has been more assailed and more ridiculed than this chapter on Pattern Cutting. Its contention for the artistic theory has been assailed by every succeeding writer, from Mr. Brophy down to Don Jose Gonzalo. Yet, notwithstanding the assay of the last-named writer, who claims the essentially scientific nature of standard pattern construction, it is not in the least intended to depart from our original contention that "pattern cutting is an art, and hence does not admit of such stringent laws for its guidance as some other aspects of the industry."*

It is not claimed that succeeding authors have not shed some light upon the best methods for the tuition of pattern cutting in classes, but it is emphatically claimed that in no single instance have they reduced the process to a science. Neither can they—else painting were science, or the sculptor's work, or that of the decorative artist. To utilise a protractor to make annular lines, to press into use parallel rulers and set squares, is not to render a process scientific. You may delimit the area within which a pattern may be found, but the delineation of that pattern is still an artistic matter, and the favour and the fervour which the scientific advocates lavish upon the use of French curves and

* See first edition of the Manual, also Polytechnic lectures.

pattern markers is a very palpable evidence for the truth of this assertion.

Let us give the honour due to our scientific friends, and tell them they have assisted us by the manufacture of some very helpful guide lines (and guide lines are used in the tuition of freehand drawing, remember, without claiming thereby to have reduced the matter to a science), and have enabled technical teachers more readily to guide the unpractised hand, and (without the least departing from the training of the eye and the practice of curves) have helped even the holders of the artistic theory of primary pattern designing to teach more readily the principles of pattern cutting, and have thereby assisted the cause of technical education, which both have at heart.

Hence, then, we still say pattern cutting is an art, and does not admit of such stringent laws for its guidance as some other branches of the trade. We here refer to "standard" pattern cutting and not to "grading," for the latter process may be worked on systems, some of which are of mathematical accuracy.

It is the first duty of the student of pattern cutting to train his eye. A correct idea of what a pattern should be ought first to be fixed in his mind. To secure this ideal it is recommended that no attempt at pattern cutting in the usual acceptance of the term should be made until preliminary matters have been well practised.

A boot upper pattern is essentially a combination of various curves, arranged one with another, according to the demands of the last and of the foot it is intended to fit. Is it not apparent, then, that one particular curve should be practised at a time, and proficiency and correctness in that attained to, before it is attempted to master the combination of the whole of the curves?

To further assist the formation of a correct ideal, the student, before practising actually as a pattern cutter, should take a pattern of the style it is desired eventually to produce, and cut a quantity of paper patterns from the sample. The practice gone through in this operation will materially assist the development of a correct ideal. Before cutting the desired pattern, however, the sample should be destroyed, together with the whole of the counterparts, and the student should at once begin to work solely upon his acquired knowledge. An elementary student should never attempt to learn pattern cutting simply by taking a pattern and altering it to suit

the requirements of the last to be fitted.* By such means it is almost impossible to acquire a sound and thorough knowledge of pattern cutting.

Experience in teaching has shown that the average student, destitute of an acquaintance with pattern cutting, fails in the symmetrical formation of even the simplest curves, and it is for this reason that the pursuance of the course here explained is so strongly recommended to all elementary students. We learn to write by imitation, we learn to draw and to paint by imitation. Why not, then, learn the art of pattern cutting by an observance of the same rules?

At this point the student needs to be reminded of the standard of beauty in Nature. All natural forms are distinguished by their symmetrical and proportional outlines. Symmetry, according to its Greek etymology, meant the state of a body of which all the members have a common measure among themselves; that is to say, it signified what we mean by proportion. Thus, in truth, the words proportion and symmetry are almost interchangeable, because, as Charles Blanc has shown,† "a symmetrical animal is always well-proportioned and a well-proportioned animal is always symmetrical. The human figure, the external conformation of the human body, having been constructed on a symmetrical plan, man desires to find outside himself the order of which he is in his own person so striking an image. More than that, symmetry exists in his mind as well as in his body, since the organ of his judgment, which is reason, obeys a kind of moral equilibrium, which is logic. A decoration without symmetry, or, at any rate, without a latent balance, would appear to us one-eyed or halting, and so would offend our sight, as not being in accordance with our understanding."

Thus, then, the need of symmetry and proportion in pattern cutting is imperative, unless the work is to fall short of the first canons of art, of which pattern cutting should, properly, be a fulfilment. When we view an object whose parts bear no proportional relation one to another, we usually deem it inartistic, as, in truth, it is. But we must remember that the reason such an object offends good taste is not necessarily because of

* It must be understood that there is no objection to the practice mentioned when one is fully competent to cut direct from the last.

† "Art and Ornament in Dress." Translated from the French. F. Warne and Co. Page 15.

actual defect, but on account of disproportion. The same parts, differently and proportionately combined, might compose a beautiful ornament, which, combined without regard to the rules of proportion, would form an insufferably ugly one.

Let the technical student, then, grasp the essence of this truth, and, having grasped it, he will not commit the usual error of the novice, and "hook" the pattern abruptly at the heel, nor choke it at the front; neither will he cut a button fly to hide three-fourths of the quarter, nor a vamp outrageously low or abnormally high. True, Fashion may interpose and foolishly demand foolish things; but, by a knowledge of certain principles, it is possible to modify what might be the ill effect of a fashionable demand by the alteration of more than one portion of a pattern. To explain our meaning: Supposing it were necessary to make two pairs of boots for exactly the same sized feet—the one to have narrow toes and the other broad toes. Practically applying this rule, the vamp would be cut narrower at the opening and with less distance between the wings for the narrow toe than for the broad toe, which should be wider at the opening, and with a greater distance between the wings, to correspond with the character of the boot. The foregoing is, of course, but an example of our meaning; the student must be prepared to apply the principle in all his work.

The next points to be considered are the regulation of pitch and inclination.

What is Pitch? The relation of the back and front curves one to the other. It is highly important that this should be comprehended, or else good pattern cutting is not likely to ensue. The things determinative of Pitch alteration are:—

1. The height of the heel.
2. The fitting of the boot.
3. The market it is intended for.
4. The nature of the last.

Starting on the assumption that in a boot devoid of a heel the curves, both back and front, of a pattern would be bounded by lines perpendicular to the ground line of the pattern, and parallel to a line running through the centre of the pattern, and calling such position an upright position, the pattern would deviate from such an upright position according to the amount of the heel added, for a low heel less and for a high heel more.

According to the degree of artificial elevation given

to the foot at the back, either by the heel or by cork elevators inside the boot, so is the inclination of the pattern affected.

Hence it follows that a pattern cut for a last intended to carry a $1\frac{1}{4}$ inch heel will not be correct for a last intended to take a $1\frac{3}{4}$ inch heel. If it were necessary to make a boot devoid of any heel, the upper pattern for such boot would have to be pitched perfectly upright, or, to speak more correctly, it would not be required to have any inclination, either backward or forward, whatever; for we may reasonably assume that the leg is at a right angle* with the ground when the bare foot is placed flat upon a plane surface. Thus, then, if such upright pattern be experimented with, by placing against the lines of a right angle, and elevating it to the necessary height for carrying, say, a $1\frac{1}{2}$ inch heel, it will be observed that the inclination of the pattern is then manifestly wrong —for this reason, that when the foot is raised artificially at the back, as with a high heel, the shape of the foot is altered.

Now, a great deal of misapprehension appears to exist in the minds of many students regarding this fact. Many well-informed students have been unable to realise that, by the action of raising the foot at the back, the curve at the back above the heel bone is made more acute. Yet that such is the fact may be readily understood by observation. As that, however, is not sufficient for some, an observation of the diagram given in Chapter I., showing the degrees of curvature at the back during different positions of the foot, will further illustrate our meaning.†

Fig. 6 shows the feet in a quiescent attitude; then slightly raised; thirdly, still more elevated at the heel; and, fourthly, that where the heel is raised most, the curvature at the back, above the calcaneum, is most developed.

When, then, the foot is artificially elevated at the back, the distance or measurement in the front (at the heel) is increased, and the distance at the back is decreased. For the heel is raised by the contraction of the muscle of the calf attached to the calcaneum,‡ which

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* See chapter on Geometrical Preliminaries.

† The diagram is taken from a good authority, Morrant Baker's edition of "Dr. Kirkes' Physiology," and should at once settle a point which has long been a matter of dispute.

‡ See chapter on Anatomy of the Foot.

contraction is a shortening in length and increasing of the bulk of the muscle. Necessarily, then, so far as the actual distance from any two points at the back of the ankle is concerned, there is a decrease; yet, as regards bulk, there is a slight increase at the ankle and lower leg. To shape a pattern at the heel for a foot under such conditions as regards elevation, it would be necessary to lengthen the front of the pattern and to decrease its measurements at the back; in fact, to incline the pattern backwards; and the degree of this inclination of the pattern backwards is to be regulated by the amount of elevation given by the heel. A boot with a less height of heel would approximate to the upright position; one with a greater height would hang backwards still more.

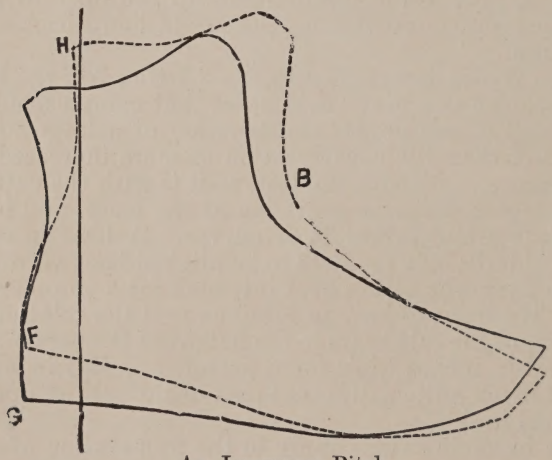
Pitch is also determined by the "fitting" of the boot. It was shown in a previous chapter that many considerations lead to the proper construction of a large fitting last other than the consideration of mere increased circumference. As with the last, so it is with the pattern. Large legs want more provision at the back, and hence more acute and larger back curves. A boot intended for an elderly lady requires to be pitched backward more than a narrower fitting boot intended for a younger person. We want to bear in mind as well the relation the position of the calf bears to the height of the person. A boot seven inches high for a person five feet in height would touch quite a different part of the calf of a person four feet high.

The foregoing rules apply to the preparation of stock patterns for the ordinary class of feet. Unfortunately, all legs and feet are not the same, nor in the same proportion.

It is the duty of the practical boot manufacturer to endeavour to fit as many classes of feet as possible, and to do so he must be acquainted with the various descriptions of feet.

Pattern cutting, however, cannot be correctly accomplished by a mere blind adherence to measurement. In cutting to measure, for instance, it is necessary to make certain deductions. But, as well as deductions from a measurement, the disposition of the dimension is an all-important factor in determining the success of the pattern. Thus, presuming it is necessary to cut a pattern suitable for a stout, portly person with a large ankle and leg measurement, we will presume, for illustration, that

we have a pattern suitable at all points, except at those just named. At the ankle and leg the pattern is too small by one inch. Now, were the art of pattern cutting merely dependent on the utilisation of certain dimensions, without regard to disposition, the task before us—of adapting the pattern to the measurement—would be absurdly easy. As it is, it is a matter for reflection. It would be wrong to place the whole of the extra measurement required either to the front or back of the leg. It must be divided, and, in this particular instance, the larger division of the measurement ought to be placed at the back of the leg. The reason may be




An Improper Pitch.

asked for this decision. It is because in a foot of the description we are considering, the extra development of the leg and ankle is caused by the lowness of the muscle of the calf. The muscle referred to being at the back, it follows that the majority of the extra measurement must be placed at that part. If the measurement were placed at the front instead of at the back, although perhaps the upper might meet, in the action of walking the boot would ruck at the ankle, and be a constant source of pain and annoyance to the wearer. Thus it is seen that other principles have to prevail in, and regulate the conduct of, pattern cutting other than the mere utilisation of certain fixed dimensions. These principles can only be thoroughly understood by a knowledge of the functions of the foot, to which the student's

attention is specially directed; for it is only by a knowledge of the positions the foot assumes under different conditions that we can expect to fit it under such varied conditions. In walking, numberless muscles are brought into action, all of which, acting on the bony levers of the foot, cause it, in the one process of walking, to assume slightly different shapes; and the boot, it is to be remembered, must fit the foot under all these different assumptions of shape. Hence the difficulty of the pattern cutter's art; and hence the necessity for a knowledge of anatomy on the part of the workman.

The long discussions that have from time to time arisen regarding pitch alteration have come about largely by a misconception of the language each cutter is employed. If we speak in future of pitch as the relation which the two curves of a pattern bear one to another, possibly the confusion between "backward" and "forward" advocates may be avoided. The higher the heel the shorter the back curve and the longer the front curve—or, to be more scientific, the more acute the back curve and the more obtuse the front curve. This mode of expression should prevent much misunderstanding.

Having given an explanation, then, of the general principles of pattern cutting, we shall now consider the actual methods of producing a pattern to a last.

In cutting to the last direct,* the left one should always be chosen to test the fit of the pattern. It is more convenient to handle, and a more correct fit is calculated to be obtained from it than from the right last.

First, get a clear idea of the style of pattern you wish to produce, noting in particular the requirement as to height of heel. Next, draw a base line the length of the pattern required; draw another line equal in length and parallel to it, two inches above it. At the right extremity of the base line erect a perpendicular line of judicious length. From the point where the perpendicular line is cut by the second horizontal line, open the compasses three inches, and mark off on the perpendicular line. From the same point, take 1½ inches, and mark off in a like manner on the perpendicular line.

* For cutting patterns without the last, deduct probable measurement across the bottom (where the filling is placed), and off joint and instep. Proceed as with heel measure. This method is useful in some exceptional circumstances, but the student should always, when practicable, cut from the last direct.

The point from which the distances were struck we will denominate A. The three inch distance shall be called AA1, and the 1½ inch distance B. These points will be referred to shortly.

Next mark off on the paper the positions of the heel, the instep, and the joints, having the last as a guide to the positions. A fair number of points is thus obtained, whereby the remaining operations are greatly facilitated.

It remains now to mark off the dimensions of instep, heel, and ankle, in the direction of the points already ascertained and marked on the paper. The points A, A1, and B will serve, in the following manner, to guide the hand in the formation of the back curve, a curve which might well be called the "key" to the entire pattern; for unless the back is something like correct, it is useless to attempt to proceed with the remainder of the pattern. At B mark off 3-16ths of an inch to the left of the perpendicular line, and a fourth point is then obtained, which we will call B1. Now, if the back curve be directed from outwards, through A1, inwards to B1, and outwards to A, a very good rough idea of the curve may be obtained.* Now finish the remainder of the outline by drawing the requisite shaped curves through the points previously obtained, remembering the principles inculcated at the commencement of this chaper in regard to symmetry. If the pattern is required for a button boot, the next operation will be to get out the vamp pattern, and, secondly, the button piece. In cutting the vamp pattern, care should be taken to avoid extremes of height and depth. The toe of the lining pattern should be placed on a folded sheet of paper, and the outline marked. The height of the vamp desired, having been previously denoted on the lining pattern, should now also be marked on the folded sheet, and the curve cut according to taste.

One rule given by some designers is that the height of the vamp should equal a third of the entire length of the pattern. In cutting the button piece care should be taken in arranging the draft—that is to say, the curve of the button piece pattern should be so much less than that of the quarter as to make the button piece clip or

* This idea was taught by Mr. Hannibal, with this difference, that he substituted a quarter of an inch for three-sixteenths given here, which has been found more generally correct.

bind without creasing. To obtain the number of scollops that the bit will carry, the following method should be adopted:—First get out the top and bottom scollops; there will then remain the intervening space to cut. In order to do away with guessing as much as possible, the exact length of the space should be ascertained by measuring, and the method for the proportional division of a line, as shown in the chapter on Geometrical Preliminaries, should be applied.†

An alternative method for obtaining a standard is now given for ladies' work. First draw a base line greater in length than the pattern to be produced. Erect a perpendicular at the right extremity thereof.

On the perpendicular line mark off a distance from the base, equal to the height of the heel of the boot, but minus the thickness of the sole (A).

Next find the position on the base line of the joint of the last (B).

Through the point set off on the perpendicular line (A) and the joint position on the base line (B) set out a straight line.

The line so described is referred to as the new ground line.

Where the new ground line intersects the perpendicular line, erect a line at right angles to the new ground line.

Set out the heel angle (usually of 45deg.).

Describe the "form" or "cover" with the joint resting on the new ground line—the back of the heel touching the line perpendicular to the new ground line, and the seat resting on it.

Set off half the heel measurement on the heel line.

Bisect the line so set off, and from the point of bisection (C) let fall a perpendicular to the new ground line (C D): with the point of bisection as centre, and C D as radius, describe a semi-circle.

Draw a line parallel to the old ground line tangent to

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† Another method, more scientific, was demonstrated by Mr. E. Swaysland in a lecture given before the Polytechnic Leather Trades Society (see report, "Boot and Shoe Trades Journal," No. 497, vol. xix.). The method displayed depended on lines which were tangent to the arcs of the button piece itself. From these combined lines a scale was constructed, minus amount for bottom scollop. The scale was then divided proportionally. With graduated scollops, the exact size of one obtained by scale was marked off in the centre, and equal distances described either side of it. Lines drawn vertically through the scale, equal to the number of scollops required, gave the proper proportions.

this last described semi-circle. This gives the ankle line.

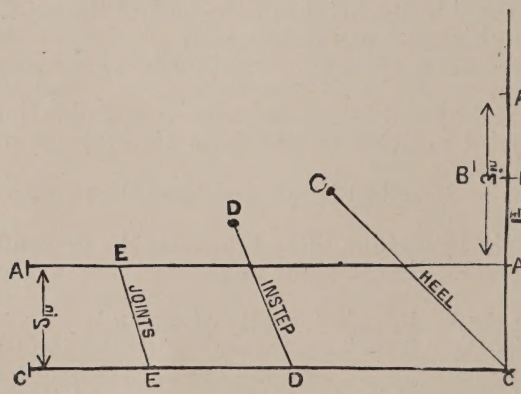
The problem is now to find the ankle centre.

To do this proceed as follows:—Draw a line parallel to the old ground line through the point on the heel line (F D) by setting off half the heel measure therein. From this point continue the line till it touches the line perpendicular to the new ground line. This gives the ankle centre construction line.

Bisect this construction line and erect a perpendicular from the point of bisection till it cuts the ankle line.

Where the ankle line is so cut is the ankle centre.

With the ankle centre as centre and one-fourth of the




Construction Lines.

circumference of the ankle as radius, describe a semi-circle.

Where the semi-circle touches the ankle line will then be the boundaries of the ankle measurement (D E).

Through the first extremity of the ankle line (D) erect a line perpendicular to the old ground line.

This gives the pitch line (F).

Deflect this line 10deg.

Mark up the new perpendicular the height of the patterm, and from the deflected line, at the proper distance, set off the measurement.

To complete the pattern join up the points so found with the "cover" pattern, and the "standard" is then complete.

Means have been devised whereby patterns can be ob-

tained with the minimum of trouble from previously obtained boot patterns. Such method, however, is not to be recommended, especially to students. Shoe patterns are far too particular in the fitting to be lightly treated, or to be obtained by any mere rule-of-thumb calculations from boot upper patterns.

In cutting shoe patterns, as with those for boots, the student will find it advantageous to use a few construction lines; they will be found best disposed in the following manner:—

1. One base line equal to the length of the pattern it is desired to produce.

2. Another placed at the right extremity of the base line perpendicular to it; and (B1) upon this perpendicular line the height the pattern is desired to be at the back should be marked.

3. A third line, parallel to the base line, and at the distance B1 from it.

The position on the last of the joint and instep measurements should be ascertained by means of dividers, and marked off through the parallel lines; the scale will then be ready for operations.

Next, the style of shoe required should be clearly decided in the mind, and a fixed idea of its contour should be secured. The work should be done independent of any copy, and the principles of symmetry elucidated in the former portion of this chapter should be steadily held in view.

Several common failings in shoe patterns it is necessary to mention in order that they may be avoided. It has been very prevalent of late years to cut such patterns high at the backs, and especially at the sides. This method of cutting is presumed to secure a better fit round the ankle. Yet nothing can be more erroneous; and the idea has only become established in practice through the ignorant demand of a public disgusted with a long succession of bad-fitting shoes; and, let us add, through the no less ignorant acquiescence therein of wholesale shoe manufacturers. Unless a shoe fits properly as a low shoe, its faults can never be effectually remedied by the pattern being cut higher on the quarters. Coming up high in such a fashion, the quarters chafe against and irritate the ankle. Perfect-fitting shoes pre-suppose perfect lasts no less than perfect patterns. A proper shoe pattern should be cut low in the quarters; and if the shoe must be high at some point, let it be so at the back only.

Another reprehensible practice some pattern cutters have adopted in attempting to secure the fit at the back. Having an idea that, if the pattern is hooked round at the top of the heel in a circular form, the pattern will unfailingly fit at the back, they carry the idea to such an extreme that great difficulty is experienced in lasting the shoe, and, when made, an equal difficulty is found in getting it on the foot—matters of no small importance.

With button shoes, the pattern for the button piece deserves special attention. All the scollops (when the usual pattern is adopted) should be so cut as to pull round the quarter, and not in a straight line over the instep, as is usually done.

Thus, then, to summarise, the following points should be guarded against in designing a shoe pattern :—

1. Cutting so high in the quarters as to reach to the ankle bone.

2. Hooking in at the top of heel to such an extent as to prevent proper lasting.

3. Placing the scollops, if a button shoe, in a straight line over the instep.

In this chapter "principles" have been mainly dealt with. If the student thoroughly grasps these principles he will find no difficulty in cutting any size of boot or shoe upper patterns.

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## QUESTIONS FOR CHAPTER V.

1.—State what you understand by the terms "pitch" and "inclination."

2.—Give a construction for a lady's upper pattern.

3.—Give a construction for a gentleman's upper pattern.

4.—Show a method for ankle construction so as to take both wide and narrow ankle measurements.

## CHAPTER VI

### On Lasts and Last Fitting.

Authorities:—Mainly Tebbutt's "Last Making and Last Measurement"—Then there are the tables and tapes published by Mr. C. F. Alden, of Norwich, and by Mr. Pabst, of Hamburg—For bespoke lasts Mr. Hannibal's "Last Fitting and Pattern Cutting"—For last fitting Mr. Lewis's book is useful—For a knowledge of the deformities and malformations necessary in difficult last fitting Mr. Rhys's book should be consulted.

However correctly a pattern may be cut of itself, that is not sufficient to produce a good fitting boot. The last must be correct also. The form of last should be such as to give the greatest amount of ease and comfort to the foot that is possible under all restrictions placed upon its form by fashion.*

Lasts may be either rights and lefts or straights. When it is said that from the economical point of view straights are best, all has been said in their favour which is possible. The feet are right and left, and the contour of the sole at the outside and inside of the foot is essentially different, and therefore requires that the sole of the boot or shoe shall have a corresponding difference. This requisite difference of outline on the outside and inside of the sole is made in the right and left shape, and it is therefore best adapted to the requirements of ordinary feet.

As a general rule, lasts, especially iron lasts, are much too large in the heel, particularly at the seat. If the foot is inspected, it is seen that the heel is not dead flat, like the seats of most lasts, but that it is convex; and, further, that just below the ankle it is comparatively thin. In some classes of feet the fingers can almost be felt, with the flesh between them, when the heel is pinched just below the ankle. With the iron lasts of machine-sewn work, how different is the case! Instead of being hollowed out just under the ankle at the heel,

* For form of bottom, see "Sole Shapes."

in conformity with the requirements of the foot, at this point we have a clumsy structure, in no degree resembling the foot for which it is substituted. French lasts possess great superiority over English lasts in regard to this matter. The heel of the last under the French system is quite round, and hollowed out from above. The stiffening being properly blocked, and the heel underseated behind, the upper clips round the foot in a proper manner, rendering the boot far more comfortable to wear. If the merit of the French last at this particular point was reproduced in English lasts, it would be of great benefit to our manufactures; for nothing can be more uncomfortable to wear, and certainly nothing can so completely spoil a boot, as too much room at the heel. The consequence of a bad fit here is to cause the heel to rock about in walking, especially upon unlevel ground. This rocking about causes the stiffening to bulge over—generally upon the inside. The whole of the foot now follows suit, the appearance of the boots is spoiled, and they cease to give satisfaction. The weight of the body being thus placed so unequally, the boots do not last half so long, and the actual wearing of boots thus out of shape is highly injurious to the foot of the wearer, and is a prime cause of treading over, weak ankles, and the like. The base of the heel of the last should be convex, like the shape of the foot, and, if this is so, in consequence of the better fit produced, there is less likelihood of the boot being run over, while at the same time the foot is not raised to such an injurious height from the ground as, from the external height of the heel, it would appear to be.

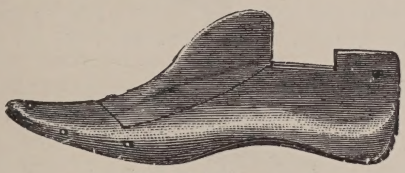
A shoe last differs from a boot last, though in the production of light work there is no good and sufficient reason why it should. A boot last is fuller on the instep, and especially at the sides, and here it is that the difference in a shoe last is principally found. Instead of being thick and full, the shoe last should be hollowed out at the sides of the instep and should taper off at the top to a thin edge, leaving a ridge or bulge close by the outside of the waist, rendering the last on its outer side almost straight.* This is requisite, so that on the withdrawal of the last, the two sides of the shoe shall lie closely together, and that on the foot the upper shall

* It may be observed that though the last may be straight here it does not follow that the sole should be straight also. The sole would be cut under at this part of the waist.

clip tightly round the ankle. It is equally desirable, it appears to us, that boots should fit closely at the ankle, and in many classes of work, such as a smart-fitting glace kid boot or a light calf goloshed gent.'s Balmoral, a shoe last is much to be preferred to the usual style adopted in boot work.*

The original distinction between boot and shoe lasts was made at a time when by the word "boot" was understood that class of footwear we now speak of as "long" work. In the case of Wellingtons, though not so decidedly of long work cut with a tongue, this distinction must still be made in order to permit of the readier entrance of the foot.

The waist of a shoe last should be slightly flatter than for a boot, and there should be rather more spring in the



Markie's Last.

toe, though this latter should not be relied upon to secure a good fit, as is too often done.

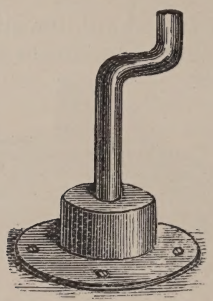
Although there has been no difficulty experienced in constructing proper shoe lasts of wood, the reverse has been the case with iron lasts. Means have now been devised for overcoming the difficulties which were formerly experienced in constructing the iron lasts. With the ordinary boot last the socket arm is fitted in a slot just behind the block, the block pressing directly upon the arm and receiving the whole of the strain incurred by hammering and the resistance offered by the arm itself thereto. Accordingly, if an iron last were made thin at the top of the block, and the socket arm fitted in the same old position, in consequence of the great strain it would soon be broken.

In the first patented shoe last, an invention of Mr. James Markie, this difficulty was remedied by altering

* It is very often that the measurements of the foot prevent the use of a shoe last for boot work. If a wide fitting boot were required, and a last constructed on the "shoe principle" were selected, to obtain the size in the best manner it would be necessary to fill up the hollow, and to so make up the necessary dimension, with the last in its proper form as a boot last.

the position of the slot into which the arm is fitted. The exact position is shown in the illustration. The necessity for this construction is now often obviated by the use of a special lasting jack (as illustrated on page 55) in place of the old peg and socket.

Unfortunately, however, by the use of a straight socket arm fitted in the centre of the last in such a manner, the manufacture of boots on the last was not an easy matter. An arm which overcomes this difficulty has been designed by one firm using the lasts for boot work, and has been found thoroughly successful. It will readily be seen that practically, by the use of this



Improved Arm.

improved form of arm, its position is the same as in the old style of boot last, whilst the extra strain consequent on the use of the old style is avoided.

Slipper lasts are similar in construction to those used for shoes. If no heel is to be worn, no spring need be given to the last, and they are almost invariably flat in the waist and along the bottom. The bulge at the side should be still more pronounced than in the last intended for a walking shoe.

In fitting up lasts for bespoke work, different considerations have to be weighed and taken into account before a decision can be arrived at as to which style of last is most suited for the end in view. If the foot to be fitted is a flat, bony one, although its dimensions might be exactly the same as a second foot which was fleshy, yet a totally different style of last would be required. For the first foot a last with good breadth of bottom, with little wood at the top, would be required; whilst for the second, probably, a last narrow in the sole and with plenty of stuff at the top would be requisite. If the last is in general character suitable, but yet

not according to the whole of the required dimensions, it will be necessary to fit "leathers" or "fittings" to the last till the required dimensions are obtained. If, however, the last is too large in some points, it will be necessary to rasp and file it partially away. If it be much too large, of course, a smaller last should be selected. Care must be exercised in placing the fittings upon the last; the general character of the last should be maintained, and the whole of the fitting should not be piled on at one point. The extra dimension should be distributed according to the nature of the foot. If the heel of the last is too small, for instance, it may be from more than one cause. The heel of the foot may have been broad at the seat, or, perhaps, thick just at the throat above the instep. Both of these circumstances would cause an increased heel measurement, but the disposition of that measurement under each circumstance would have to be different.

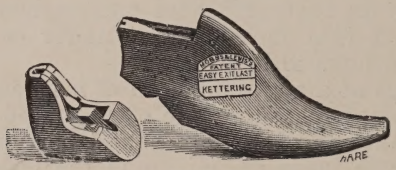
The insteps of the ordinary run of lasts are generally anything but correct; they are often placed directly in the middle instead of at the thickest portion at the inside, where the large toe joint and the largest toe are placed. When the foot is normal, the rise at the instep is pronounced and graceful. With a good shaped instep a difficulty in fitting sometimes occurs, owing to the prominence of one of the tarsal bones.* This bone is more or less prominent in all feet, but especially so in "muscular" feet, and although it does not necessarily occasion tenderness at the part, yet when the bone is prominent a great tenderness is oftentimes experienced, and when thus occurring is a cause of trouble to the last-fitter. Especial care should be taken in measuring the foot, in order to obtain the exact distance from the heel that the tender spot occurs. Under the old systems of measurement this distance would not be taken, whereas in a foot of the description we refer to it is a most vital matter. If the instep of the last is placed too far back it does not reach to the point required; if placed too forward it allows the foot to slip towards the toe of the boot, rendering it to all intents and purposes too short. If the measurements be taken as directed in the second chapter, the first and most necessary step will be taken in securing an easy fit to the tender instep. An American method of measuring the foot for a tender instep

* The external cuneiform at its articulation with the fifth metatarsis.

may also be found useful:—"Draw the strap measure from the point of the instep around the heel to give the size, while the distance between the same two points in a straight line should be taken by the size stick, in the same way we take the length of the foot, to show how far forward the point of the instep ought to be located on the last. The measure around the foot at the latter place must also be taken."

The toes should also be properly provided for; and although this matter has already been treated under "Sole Shapes," yet, as their proper comfort depends as well upon the shape of the upper portion of the last, we will further consider the matter here.

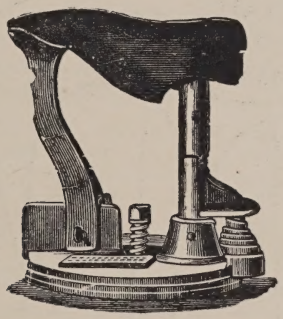
The old form of "duck bill" toe is now, happily, obsolete; many lasts, however, still suffer from a form of




Easy-Exit Last.

the same evil. The last should, of course, be longer than the foot it is intended to fit, and it stands to reason that it should also be as thick at the toe end as is the substance of the foot at the point referred to. A flat-toed last is a frequent cause of injuring toe-nails. The boot upper pressing upon the flesh against the nail of the great toe on one side, the nail is almost compelled to grow into the flesh if it grows at all. The toe under these circumstances, we are told by Dr. Meyer, "gets into a state of chronic inflammation, and may eventually become ulcerated, producing what is popularly known as proud flesh." When this evil has become set in the foot, the last must be made specially easy at this point, or even when the foot shows the least tendency to it. "The ailment not only interferes with the use of the foot but too often requires for its relief medical and even operative interference"; and it therefore behoves shoe manufacturers to prevent the evil as much as possible by the avoidance of flat-toed lasts. Beyond causing ingrowing toe-nails, a flat-toed last, whatever may be its width or shape, has a bad influence in causing the nails to turn down at the ends, keeping the toes irritated and sore.

In the manufacture of boots and shoes the usual form of the divided last has presented some evils, the principal being the difficulty with which the last is withdrawn when the boot is lasted. Several modes have been invented to overcome this difficulty, all of which depend upon a new division of the last at the heel portion rather than at the instep, as under the old method. The last illustrated on page 54 is a type of the class referred to. Iron lasts are also made with wooden blocks, and the combination has many advantges. An iron last is only required in order that the nailing parts of the machine-



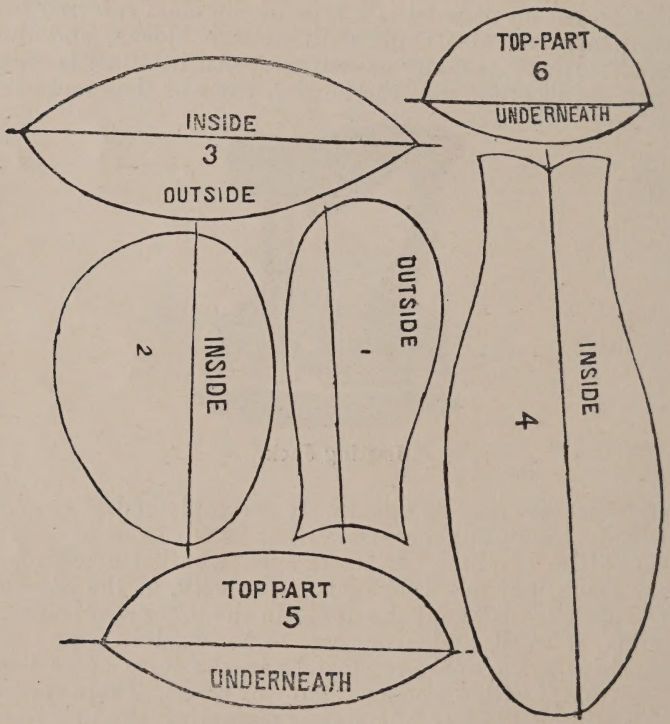
Lasting Jack.

sewn process may be effectually accomplished. Thus it is only absolutely necessary that the bottom of a last should be of iron. In fact, such iron-bottomed lasts are made, but not used very extensively, as the edge of the plate tends to cut the upper in the process of lasting. Thus, if wood and iron are to be used in a last for machine-sewn work, it must be in the form of an iron "bottom," with a wooden "top" or block. There is considerable difference of opinion respecting the utility of a wooden block, though probably, all things considered, it has more advantages than the block of iron. It is well known that lasts cannot be cast, or, at any rate, are not cast with strict accuracy from wooden models. Therefore it would appear that, where the actual incorporation of any part of the model is possible, such a course would be highly advisable. With wooden blocks lasts can be better fitted for bespoke, which is an advantage not to be overlooked.

Lasts that are used in the production of machine-welted work are of a distinct pattern to accommodate their use upon "lasting jacks" as opposed to the ordi-

nary upright and socket. Such lasts have a hole drilled in their centre, and are usually plated at the seat to permit of the seat being nailed in when thought desirable.

The general principles of lasts having been considered, it is necessary to show how they may be adapted, by the




A Set of Fittings.

aid of various descriptions of fittings, to special cases occurring in bespoke work. Fittings may either be of leather or gutta-percha. The leather fittings should be first cut to some definite shape, and patterns made by which they may be cut as after requirements may determine. Sets of fittings, however, should always be kept handy, ready for use at any time required, thus saving time when work is hurried. The shapes which in our experience have proved most useful are six in number, and are designated:—

(1) Instep piece.
(2) Full joint piece.
(3) Side joint piece.
(4) Long front piece.
(5) Inside waist piece.
(6) Outside waist piece.

The illustrations here given show their general shape, and their names indicate to which divisions of the last they are usually applied. The exact mode of their adaptation will be dealt with, after the manner of their preparation has been explained.

In cutting patterns of the shapes here given, regard should be had for size-sets, according to the size of lasts used. Thus, sets may be classed as follows:—Taking the number of sizes from 1's to 12's, there should be four sets of fittings marked out as below:—

| | | | |
|---|---|---|---|
| The set prepared for size | 2 | suits sizes | 1, 2, 3. |
| The set prepared for size | 5 | suits sizes | 4, 5, 6. |
| The set prepared for size | 8 | suits sizes | 7, 8, 9. |
| The set prepared for size | 11 | suits sizes | 10, 11, 12. |

It is obvious that there must be sets of fittings to correspond with the increase in the sizes of the lasts, a set of fittings for a 3's last being plainly not applicable to a 1's. Yet it is not necessary to have sets for every size, and the list here given is classified in the most practical manner we can suggest.

We have now to consider the manner of preparing these fittings. First cut (by trial) a set of paper patterns to fit last 2. They should be of the shape and sort particularised in the illustration. By reference to the table it will be seen that this set would suit sizes 1, 2, 3. These patterns can be reproduced in zinc or stout card. By reversing the patterns when cutting the leather, the fittings will be cut right and left. This is necessary if it is desired to fit the lasts neatly. Paper patterns should now be prepared in a like manner for sizes 5, 8, and 11, so as to complete the four classes as per table.* The leather fittings thus obtained from light shoulders should be wetted, and when thoroughly soaked should be carefully skived round the edges. The skiving should be performed on the flesh side, as if the grain is not touched it will present a neater appearance, besides which the grain, when dry, clips better on the last. The skiving should be a half-inch in width, and the edge should be

* If the 11's set were cut and the 2's, the intermediate patterns could be obtained by the comparative method of grading.

reduced to the substance of a sixpence. After skiving, and whilst still mellow, they should be blocked on the last in order that when dry they may conform to its shape.

It will be readily seen that, with a stock of fittings prepared in this manner, the operations of last fitting are rendered much easier.

In affixing the fittings to the last small French tingles are the best to use, as they make but a very small hole, and allow of the easier transfer of the fittings when necessary.

In considering the adaptation of these sets of fittings we shall treat of them according to their number in the illustrations.

No. 1 is used for increasing the bulk of the instep, and should be long enough to reach to the joints.

No. 2 is used where it is intended that the last should be fitted for a thick foot.

No. 3 is used along the outside or the inside of the last, principally along the outside—when the last is intended for a thin, broad foot—as it increases the measurement without increasing the thickness of the last. This side fitting is especially useful in fitting lasts for feet with bulky toes; or toes that are arched, if the fitting is placed forward on the last. For persons with a full outside joint the fitting should be fixed lower down along the outside of the last.

No. 4 is useful for increasing the measurement of the joint and instep with one fitting. It is synonymous with the old "shover."

No. 5 is useful for fitting up shoe lasts, or for feet having no arch in the waist. It is also useful in some forms of flat foot.

No. 6 proves useful in fitting shoe lasts also. It is especially handy in a case of broken-down instep, when, as sometimes is the case, a bone protrudes on the outside waist of the boot.

The heel pin, which it is hardly necessary to depict here, is for lengthening the last at the back, increasing the measurement of the heel. Except in very special cases, its use is fraught with danger, and it is not to be recommended, at any rate, to the beginner.

All fittings may be used in conjunction with each other when found necessary.

Fittings of leather one-eighth of an inch thick will generally make a difference in the girth measurement of

a quarter of an inch; this, of course, depends on the width of the fitting—if very wide the increase will be greater; if narrower, less.

Many fit up lasts by affixing pieces of leather with wooden pegs, and afterwards paring up to shape with the knife. There is no system about this mode, but with extremely difficult lasts it has sometimes to be resorted to. If this plan is adopted the leather should be put on flesh side outwards, as it looks better and neater when pared.

Gutta-percha is a valuable adjunct to the last fitter, as by its means he can mould forms which it would be difficult to produce neatly and quickly with leather. When applying it, the gutta-percha should be held over the low flame of a spirit lamp and gently heated (but not allowed to burn), and then applied with the wet thumb and fingers. If it is desired to apply the gutta-percha to the iron lasts, the lasts should also be warmed, the condensed vapour consequent on the foregoing process removed, and the percha applied in the ordinary manner.

In fitting up lasts for special deformities, thought must be exercised to meet special requirements for individual cases. The usual method of fitting up the last for a bunioned foot is to provide a deep receptacle for the enlargement. Yet, as one writer* has remarked, this receptacle is very often placed in a position totally incorrect, and the painfulness of the bunion is thereby increased rather than lessened. Although we do not hold to the full extent the views advanced by the author we mention, we must admit that he has great cause for his severe strictures upon the old method of last fitting in this respect. The whole of the extra measurement

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* Mr. Hannibal maintains that the insole should be perfectly flat, as in the case of a boot for a healthy foot. He says the provision of a receptacle allows the bunion to develop. If a proper shape is given the boot, we deny that is, or can be, the case; and in support of our contention would refer the reader to a case (albeit the type of many others) recorded by Dr. Camper, chapter vii. He mentions the case of a sufferer from bunions. and says:—"When I was summoned I examined the foot and found a callous mass which had formed upon the anterior portion of the great toe. I made a species of receptacle of cork for the diseased toe, carefully removing with a file every particle which could press upon it. This little contrivance was fastened to the toe, so as to protect it entirely from injury . . . and my patient found himself immediately able to attend to his affairs . . . and in six months a complete cure was effected."

demanded for a bunion should not be obtained by simply placing an abnormal enlargement at the supposed position of the diseased joint. The form of the last should conform in a degree to the form even of a diseased foot. The ball of the last should be slightly rounded by the addition (if an old last) of gutta-percha at the bottom, and the sole should also be made more hollow in the arch of the transverse portion of the forepart. This will be but a slight exaggeration of the form given by Nature, and if the ball be continued slightly on the top side as well, the boot will prove most comfortable. It must not be inferred from the above remarks that we believe in the theory which places enough on the last to allow of the complete burial of the bunion in the bed formed in the inner sole. We recommend that a part of the measurement shall be placed on the sole and a part on the upper portion of the last. This method in practice is found most practical and generally successful.

It is a great fallacy to suppose that weak ankles may be cured by the use of hard bandages and springs. Such means destroy the necessity of the action of the muscles, and the inevitable consequence of inactivity is a decay of the muscular power. "The law of growth and strength is use, exercise, and labour," and, accordingly, anything which tends to retard the free action of all the muscles should be steadfastly rejected.* The last should be hollowed out in the waist very much, and in the making of the shoe a cork pad should be worked in to fill up the space. By this means sufficient support will be afforded the foot without retarding its action.

A matter closely allied to weak ankles, and which necessitates an alteration in the last, is that of treading over. This is invariably occasioned by the fallen condition of the arch of the foot on one side. Thus, if the body's weight is borne, not in the centre of the boot as it should be, but rather on the one fallen side, it is seen that the chances are that the foot will tread over that side. To prevent this it is obviously necessary to afford extra assistance to the weak portion. A prevailing cause of flat foot is the short heels which are usual in some classes of work. To afford extra assistance to the fallen arch at the outside, the heel should be long; and, further, it should be longer on the weak side. The boot or shoe should also be made upon a flat-bottomed last,

* An instance of the evil consequence of binding the foot up tightly is seen in the calf of the agricultural labourer.

and the stiffener should be disposed so that its stiffest side is on the weak side of the foot.

The principal remedy must be sought in the form of the last. With a foot that treads inwardly the last should have the appearance of being inclined over outwardly. Thus, to this end, the bulk of the wood of the last should incline toward and be on the outside. The outside edge of the sole of the last, especially at the heel, being also pared off, the further appearance of outward inclination is given, and as it is the intention that the boot or shoe made upon the last should have the tendency to coax the foot to the outward side, such an appearance in the last is highly desirable, and is what is sought for.* If there is no flatness at the waist of the foot, there need be none at the shank of the last; if the foot is somewhat arched on the inside, the cork pad referred to in a previous paragraph could be utilised. Under all circumstances the heel should be long, so as to render support to the foot. In some cases of flat feet which spread over, the use of a spring in the waist is beneficial. Those feet that tread outside need exactly a reversal of the application of the principles for the inside treading feet, the main bulk of the wood between the heel and the instep being on the inside, rendering the last fuller in that part.

Thus it must be remembered that the last that would appear to fit a foot that treads outwards is just the one to be used for a foot that goes inwards, and vice versa.

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## QUESTIONS FOR CHAPTER VI.

1.—Why would you consider "straights" inadvisable?

2.—Is any special care needed in measuring the instep for the purpose of last fitting?

3.—Describe the difference there should be in a (a) slipper last, (b) boot last, (c) shoe last.

4.—How would you fit a last to make it suitable for a foot with a weak ankle?

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* Care must be exercised in lasting the upper upon a last of this nature.

## CHAPTER VII.

### The Elements of Geometric Last Grading.

[This is a synopsis of a lecture delivered by the author in 1887 before the Polytechnic classes, and was originally published in pamphlet form by the Institute.]

HITHERTO the process of arranging lasts into sets has been left entirely to the dexterity and judgment of the operator, regardless of any rules. In this chapter an endeavour is made to explain a system whereby last patterns may be graded with mathematical accuracy and in strict proportion one to the other.

The grading patterns may be classed as Insole or Bottom Patterns, Breech Patterns, Instep and Joint Tapes, and Cross Sectional Patterns.

The first operation in any process of grading or designing lasts must be in connection with the Bottom Patterns. The Insole Patterns, being the shape of the bottom of the last, should be graded first. It is necessary to secure a good "standard" from which to grade; for this purpose you cannot do better that practise the method which has been previously explained, which, to recapitulate, is briefly this:—Obtain the first width of the seat; then draw perpendicular lines at either end of the heel-base, equal to the length of the standard required; divide the base into ten equal parts; and, having ascertained the exact positions of the bearings, place two parts on the outside and one on the in.

The standard thus procured may be graded either by the rule formulated here or by comparison. Thus, with the initial stage of last grading, little or no difficulty will be experienced. The Breech Patterns, of which we shall now treat, will be found rather more troublesome.

By the Breech Pattern is meant a plain sheet of paper from which a centre pattern has been taken, leaving an opening into which a last of requisite dimensions will exactly fit.

The standard from which to grade may be obtained either by dividing the last lengthways, and thus obtaining a sectional view, or by a breech pattern obtained by trial. The last method is preferable.

Describe the sectional view thus obtained upon a sheet of stout paper. Draw a line running through the length of pattern. Thus, if the standard is a 4 size, this line running through the pattern would measure $9\frac{3}{8}$in. This will have to be bisected to obtain the radial centre, which in this case it is found preferable to place at exact mid-distance on this line, which we will call XX. The last grading form is a 4's; it follows, there being three extra sizes beyond the 4's to grade (the 5, 6, and 7), that three extra sizes, or one inch, will have eventually to be added to provide the full length for the largest size. The radial centre being placed at exact mid-distance, one-half of the length of the pattern being on either side, it follows, if any addition of the length be made at the heel, that that addition must be only one half of the full complement. We find it most convenient to grade from the heel; therefore the half additional length required ($\frac{1}{2}$in.) is placed beyond the intersection of the outline on XX.

This system of last grading is based upon the theory that, on lines radiating from one common centre through the outline, the projection on such lines of a given point outside the pattern, from two given points on the pattern, is the strict proportional position of another.

Now, by placing the half additional length on the back, the prime outside point is obtained. The intersection of a radial line is one given point on the pattern, the second given point being the intersection of that radial line from which the prime outside point is projected. Thus, in this case, we will assume one radial line cutting through the outline exactly at the top line of the heel, and we will call it B. The half additional length has been placed on XX; the extremity we will call A. It is necessary to project A on B.

Now for the application of the rule: A is the given point outside the pattern. The intersection of B is one point on the pattern. XX being the "radial line from which the prime outside point is projected," the intersection of XX is the second point on the pattern. The essential working points thoroughly understood, it but remains to show how A is actually projected on B. Place

the set square level with the two points on the pattern; slide it out until it reaches the point A outside the pattern, and a line drawn from A, when the set square is in that position, through B, will give the proportional position of another pattern, the intersection of this line through B being the exact point A1. Now, again, this point A1 is a second given point outside the pattern, and the intersection of the radial lines the points on the pattern; so that the process in its operation constantly fulfils the conditions for its further working. The process continued around the outline of the pattern will eventually leave the requisite addition on the front of the pattern, thus checking its own working.

To obtain the intermediate sizes the spaces may either be divided with the compasses, or the outlines worked from a less prime point, and continued as for the sevens. This stencil, when cut, will provide the necessary breech patterns, by which the last maker may very conveniently test and conform the pitch of his lasts.

Other points, however, have vital relation to the pitch in determining the general accuracy of the set.

It is very general to compute the girth measurements at joint and instep by certain arbitrary divisions of the inch. Although it is necessary that inch measurements should be given to lengths, there is no reason that widths should be similarly treated. On the contrary, they are far too complex to be measured in the ordinary way, as the following simple calculation will show:—If a 5-size last measure $3\frac{3}{4}$in. across the tread, its width at that point is exactly one-third of its length. In strict proportion, therefore, a difference of a third of a size, one-ninth of an inch, should be made between size and size in the bottom measurement.

But if the width were greater or less than $3\frac{3}{4}$in. for the same size, its proportionate width to length would be altered, and so the same difference between size and size would no longer give a satisfactory result. Speaking roughly, a last generally will be three times greater in length than in width.* Thus, the strict proportionate difference would be one-ninth instead of an eighth, as usually reckoned. This difference, though trifling in the single instance, is intensified and exaggerated in grading.

To calculate these differences by the rules of arithmetic would prove a troublesome process; hence, we call

* "Lasts and Knives, and How to Prepare Them," chap. 1.

in the aid of this rule of proportional grading to automatically reckon these width gradings.

The application of the rule is as follows:—Prepare a tool as for upper pattern grading. Measure the last at the joints. Presuming the measurement to be 8¼in., draw a line commencing at a point directly under zero of the tool. Mark off on this line the distance 8¼in. Draw a perpedicular line from this point, cutting through the converging lines of the tool. The distance between the spaces where this line cuts is plainly seen to be the strict proportional allowance between size and size at the joint. The measurements thus described upon the line should be duly registered on a stout slip of cartridge in the form of a tape; the last maker can use it then with ease. The instep proportions are obtained in exactly the same manner; that is, by measuring the girth of the standard at the instep, and striking the line through the tool.

Cross sections cannot here be dealt with. The student who grasps the theory of the working thus far will experience no difficulty in this last stage.

## CHAPTER VIII.

### The Principles of Clicking.

Clicking being the primary manipulation of the most expensive item in boot and shoe manufacture, it is of the greatest importance that its practice should be built on true theory.

So many diverse opinions are held as to what constitutes a perfect system of clicking that it is hardly to be expected that the views expressed in this chapter will in their entirety find favour with everybody. It is hoped, however, that our views are stated and supported in a manner so far reasonable and logical as to commend themselves to the candid consideration of all concerned in cutting out the uppers for boots and shoes. We have endeavoured simply to express ourselves after the manner of a famous author, "to play the part of a sieve," and to separate the well-established and the essential from the doubtful and unimportant of the mass of knowledge, experience, and opinion which has been recorded, bearing on the process of clicking. Thus, in this chapter, we have submitted a series of principles rather than of detailed manipulations. So many things occur in clicking to upset mere plans of placing patterns that, although we are no advocates for leaving everything to experience, we feel confident that the greatest good can be brought about by giving principles, the exact mode for the application of which can be best determined by practical experience. One method suits one case, and a modification of the method suits another, so that to lay down hard-and-fast rules would be absolutely absurd.

The great characteristic of the skin to be kept in view is that referred to when we speak of "stretch." Stretch is the technical term applied to the property of skins which renders them tighter in certain directions than in others. In those directions in which a skin is least yielding when pulled, it is said to run "tight." Nearly

all skins are tight in the same directions, which are as follows:—At the butt from the backbone, in the direction of an angular line of 60 degrees with the back-bone, and radiating off in a similar direction to the side, these meeting similar radiations from the back-bone to the flank; at the neck the line of tightness is upward, and in continuation of the radiation from the back-bone to the flank. From the fact that in nearly all animal skins these directions of tightness are the same, it must be assumed that the quality is dependent upon the actual structure of the skin, and not upon any process of manufacture. What particular parts of the skin influence this quality have not yet been clearly defined, though it is tolerably certain that the cause is the same in all skins. If the directions of the lines of tightness are understood, it is possible to cut the uppers so that they shall be most unyielding in certain fixed directions. They may be cut in such directions as shall render them tightest from heel to toe, which method of clicking is referred to as "heel-to-toe" clicking; or they may be cut up the front seam, which last method is said to be that of "tight seams."

Although the matter of stretch and tightness is of the utmost importance in such leathers as glove kid, it is safe to say that its importance has been somewhat exaggerated in reference to leather of which calf kid is a type. Necessarily, leathers of the highest quality require the greatest care in clicking, and the way of the stretch in such leathers should be strictly regarded. Leathers of the nature of English and German calf kid, however, for all practical purposes have no stretch—that is to say, those parts that do stretch are offal, the portions which are most unyielding being the major quantity, and being alone used under any method of clicking, on whatever theory its operation may be supposed to depend. In leathers of the type referred to, several principles should be kept in view, and should be followed as more practically correct than a slavish adherence to lines of tightness.*

Under the usual methods of calf kid cutting, the skin is started by cutting quarter patterns either side of the

* This explanation is necessary for lucidity. Many students confound the directions in which a skin is tight with those in which it is loose. This is probably owing to the frequent use of the phrase, "the way of the stretch," when referring in reality to the lines of tightness.

back-bone. Thus the whole of the quarter is secured from the best portions of the skin. Now, this is not advisable. It is apparent that where the least wear occurs the lower quality of leather should be placed; and that where the greatest amount of wear devolves there should be the best quality of material possible. Now, the top of the leg of a kid button boot is probably the point at which a boot receives its minimum amount of wear; thus, then, this part should, if possible, be cut from a portion of the skin lower in quality than that from which the parts that are subjected to most wear are obtained, especially when it is supported by a leather top band.

The first principle, then, is that the offal should, as far as possible, be cut in to the tops of the legs. This principle is illustrated on Plate I. The skin, instead of being started from the centre, either side of the back-bone, is commenced by obtaining quarters from the lower half of the planned out skin. By this means the least valuable of the material is cut into the most suitable portions of the boot, and the best leather is cut into those portions at which the most severe wear is sustained.

Next, starting from the back-bone, the vamps and button pieces must be secured from the prime leather left at this point.

When these have been obtained, the same process of placing the quarters and then the vamps is repeated so far as is possible; but, of course, it will be found more difficult to place the patterns in this second setting. The disposition of the patterns in the centre must determine, to a certain degree, the exact position of the quarters; but the general principle of securing the tops of the legs as near the edges as possible must be steadfastly held in view.

As an additional principle, it may be held in view to obtain the quarter commonest on the front edge (where there is any choice), for the outside quarter to be placed under the button piece. A small defect may often be worked in in this manner without any real detriment to the boot. It must be remembered that it is essential to have the whole of the remainder of the outside quarter as good as, if not better than, the inner one. The idea that the button-piece will cover a "multitude of sins" in the outside quarter must not be indulged to the extent which it is too often done. It is practicable to use the button piece to cover small flaws, but the general qua-

lity of the outside quarter should be quite equal to that of the inner one. In some sets of patterns the outside quarter is cut smaller than the inner one, and is usually, as well, rounded off in a particular manner to prevent the possibility of the fitter mistaking it for the inside quarter to which the button piece is attached. This system has some advantages, as is plainly evident from the fact that, being of smaller area, it will often fit in where the larger one will not, and, the top curve being rounded off, its fitting is rendered still more economical. From a retailer's point of view, rather than a virtue, this method is a serious disadvantage; as when it is required to alter buttons (as some retailers find it necessary to do) the stocking shows through the button holes, giving a very unsightly appearance to the boot.

The method of clicking described in the previous paragraphs, though not a generally accepted one, will be found productive of good results, and it is by that it should be judged.

It may be urged that it must be the truest principle to use up the best portions of the leather first, as less restrictions are placed upon the first cutting of the patterns, and more patterns are at disposal at the commencement; and that, consequently, there is greater scope for economising those portions of the leather which are of most value, and over which the greatest care should be exercised.

The argument would be very good were all the portions of a boot upper as large as the quarters. Fortunately for the method of which we are now speaking, they are not; and if the process is followed by cutting the largest portions—the quarters—around the skin, in the manner exemplified in the illustration, the smaller portions—vamps and button-pieces—will be left to be schemed from the prime leather left when the quarters have been obtained. By this means the prime leather will be used for those parts at which the wear is most severe, viz., the vamps and button-pieces; the lower parts of the quarters will be in the good parts of the skin; and the tops of the legs will be of the least valuable of the materials.

It is well known that there is a greater probability of economically fitting a number of small patterns into a specified surface than there is of fitting a smaller number of larger patterns. Thus, an area the extent of a pin's point could be distributed over a skin, however flawy, without the possibility of waste; whereas, taking

another area the extent of a pin's head, there would be some waste, though of a microscopic order. But, enlarging our ideas, do we not see that there would be more probability of economical fitting if a pattern the size of a halfpenny were distributed over a surface than with a pattern the size of a penny? The following illustration will further explain our meaning:—

At Figure I. is represented a certain surface. We have two circles of different radii, and we experiment with them to prove the economy of small patterns. Thus, with the circles of the greater radius, we find it is only possible to distribute two over the area; so the remainder, for the present purpose of our argument, must be

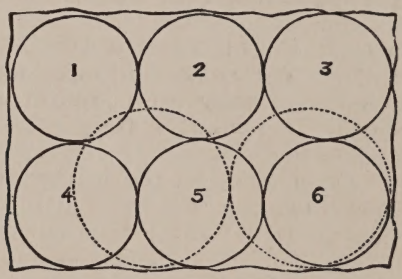


Fig. I.

considered waste, as we have no smaller pattern to run in. We next try the smaller circles. Of these we find it is possible to distribute six, and with but a minimum of waste.

Now we desire to show the analogy of the case of cutting the edges of the skin as we have described.

We have assumed that it is argued the prime part should be cut first and large patterns used, because the restrictions are at the commencement fewer, and there is greater scope to economise the best parts.

Under the method of clicking at present being discussed, the legs are cut first with the tops directed to the offal. The centre of the skin is left for actual cutting till last, but a general idea of the disposition of the patterns in relation to the quarters is kept in view.

Now, by cutting the quarters in the manner described, the possibility of the largest amount of waste is confined to the least valuable portions of the skin, and by cutting the vamps and button-pieces into the centre —such patterns being of smaller area than the quarters

—it follows that the probability of waste is least at the best parts of the skin.*

Thus, then, our first general principles of clicking are:—

(a) To keep the offal as much as possible to the top of the leg.

(b) To get the fronts and such parts as are subjected to most severe wear in the best parts of the skin.

(c) To get the quarter commonest on the front edge under the button piece.

And the reason for the advocacy of these principles is that there is more probability of a small pattern economically covering a specified area than there is of a larger one so doing.

In the endeavour to fulfil these first two principles, it will be necessary to observe other minor ones. Thus, the patterns should be arranged that the vamps lock in one with the other. By doing this, the greatest economy in actual cutting is secured.

Under some of the older systems of clicking the vamps are cut without much curve; this principle should not be resorted to in the endeavour to make the patterns fit in. Every precaution should be taken, but the patterns must on no account be made to suffer.

Another principle to be kept in view is the inclination of the patterns on the skin. If one pattern is placed in wrong "slant" it will often upset the whole idea on which the skin has been planned. In cutting under the system we are now considering, it is necessary to keep the patterns square one with another in the manner shown on Plate I. Unless this is done, the whole scheme will be rendered unworkable.

In starting the cutting of a skin in this first manner it is necessary to fit the quarter patterns in the position shown on the diagram. The placing of these quarters is the keystone of the system, and unless proper attention is paid to their situation it will be useless to expect the remaining patterns to fit properly.

Thus, then, the conduct of the system is—1st, to fix

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* This principle of the areas of patterns in relation to the quality of the leather should be kept in view in all descriptions of clicking. It is because the principle is a fundamental one that we have devoted this space to its more particular consideration. The method of clicking recommended is not a usual one, and therefore requires an apology.

the quarter patterns as previously referred to; 2nd, to continue planning with the quarters square one with another around the edge of the skin, having a general regard to the disposition of the vamps, etc., in the centre of the skin; and, 3rd, to lock the wing of one front into the opening of the other, in order to avoid waste in cutting.

In cutting Balmorals, different principles must be

Plate I.—Kid Skin Planned on the Outer Edge System.

kept in view to those for cutting button boots. It would not, of course, be possible to have one quarter smaller than the other, nor to cut flaws to the edge of the quarters. Modifications of the foregoing principles, then must be employed in cutting Balmoral work.

Plate II. shows an alternative method of cutting the same skins. This system will be found to answer better for Balmoral work, though the same patterns are used to exemplify the system as were employed for the skin depicted on Plate I. This has been purposely done in order to show the advantage from an economical point

of view of the first method of clicking over the second. The principle kept in view is to get the uppers tight up the seams*—the tight seam method referred to at the opening of the chapter. Under this method the skin is started from the centre—that is, from either side the

Plate II.—Kid Skin Planned to Cut Tight Seams.

back-bone. This is the most usual starting-point. In this method, as in the former, the patterns must always be kept as square as possible one with the other.

Additional principles should be regarded in the use of this method:—

* The diagrams of skins here submitted are facsimiles of actual skins, and the whole of the flaws found thereon are depicted in the diagrams. As our purpose is to explain a "system" of clicking, a nearly perfect skin has been selected to exemplify the descriptions given in the text. The student must modify the system to meet the requirements of damaged skins, but must always keep the principles to the system in view.

(1) The vamps or button pieces should be placed so as to fit in the front curve of the pattern, as shown in the diagram of skin on Plate II.

(2) The peak of the quarter should be fitted into the opening of the vamp, as also shown on Plate II.

Objections have been urged against this method of placing the patterns, the principal being that the uppers stretch in the lasting from heel to toe. Of course, it is highly desirable that the uppers should be tight in all directions, but when economy has to be considered this cannot be accomplished. The question then resolves itself into this: Which method of placing the patterns presents least evils?

In lasting, the upper receives its most severe strain from heel to toe; but it must also be remembered that an amount of strain devolves upon the front seam in lasting the sides. Further, it must be remembered that good lasting does not depend upon the greatest amount of strain being placed upon the uppers in the process of lasting, but rather vice versa. Thus, the strain an upper receives during the process of lasting is a strain which can be greatly modified by the skill of the laster, whereas the strain a boot or shoe upper receives during wear is dependent on the action of the foot and on the peculiarity of walking, and not on the pleasure or skill of the individual. The one strain is helpable; the other in a large measure is not.

Thus, then, we have to consider under which method of clicking the strain received by the upper during the action of walking can be best provided for, and whether the strain is most severe from heel to toe or along the front seam.

In analysing the ordinary actions of the foot in walking we find its greatest number of movements are necessitated in the actions of raising the heel and flexing the foot, and not in its extension. It therefore follows that the movements are most free at the ankle and instep, and hence that most strain devolves upon the uppers along the front seam.

In proof of this assertion it may be here remarked that one of the common points at which seams are found to yield is just at the front curve of the upper, at the point where the heel measure is usually taken, thus showing that the greatest strain is upon the upper at that point.

In cutting calf kid, however, it will be found more

generally correct to adopt the method exemplified on Plate I. It is a method upon which first-rate results have been obtained in clicking such leathers. Our purpose in introducing the argument for and against tight seams is that the student may have an intelligent knowledge of the principles of clicking, in order to properly progress in his studies.

With a knowledge, then, of the principles of calf kid cutting (a type of many other leathers), the question of wholesale cutting has now to be considered. We have referred to the cutting of the single skin; we have now to discuss the methods of cutting dozens of skins. It is a point in dispute whether it is better to cut offal into whatever it will make and hold cut stock, or whether it is preferable to save the material uncut and use it subsequently.

It is decidedly very erroneous to have an accumulation of offal. Once any amount of offal is obtained, it will be hard work to reduce it; the tendency will be to greater accumulation, and it will consequently be harder to get rid of. When the offal is not cut there is a great danger of wrong casting. Thus, as far as is possible, the whole of the skins should be cut up at once. As fashions do not change very rapidly, there is but little danger of having a lot of useless stock. To cut the whole at once it is necessary to use several sizes and descriptions of patterns in cutting one dozen of skins. It is useless to expect economical clicking if only one size of pattern is used, and that oftentimes the largest size, as is done by some manufacturers. For it is apparent, by reference to Fig. I., page 70, that if only patterns the sizes of the two largest circles were at disposal for cutting the area there specified, the cutting would be very wasteful, as the area will only take two of the circles in their complete form. If, however, smaller circles were also at disposal to run in with the two larger ones, then it is readily seen the cutting might be rendered much more economical.

So it is with cutting leather; if it is desired to use it economically, patterns of different sizes must be used in cutting the one dozen of skins.

In commencing a dozen skins, they should be sorted out for the various classes of work first; they should be sorted for substance and size, the largest skin being first operated upon with the largest pattern. Thus the largest sizes will be obtained stouter in substance. This is highly desirable, for although perhaps a very great

deal more wear may not devolve upon a 7's woman's than on a 2's woman's upper, yet the larger size takes the stoutest substance better, and produces a less clumsy boot with it than would the 2's. If the stoutest substance is not pre-eminently adapted to the 7's it certainly is not more adapted to the 2's.

In the clicking of waxed calf, probably more offal has to be contended with than in any other class of leather. As far as possible it should be the endeavour of the manufacturer to use the whole of the offal in his own goods, and not to sell it at so much per pound to other manufacturers, as the cost of the goods is greatly increased by the latter system. The necks, too, are often found to be so rough on the blacked side as to render these parts of waxed calf skins useless for any but the lowest classes of work. If the necks, however, are recurried on the flesh side (which any currier will do at a small cost), the difficulty with the necks may be overcome. True, the leather will be veiny, but it is of good wearing properties, and is eminently suited for the legs of men's and boys' stout work. Indeed, it is used in this manner in some of the highest class of hand-sewn work.

Female skins are preferable for ladies' work, being much lighter in the necks and of a finer texture throughout.

The male skins are coarser, especially at the necks, and are more suited for men's work.

Female skins may be judged from those of males from this difference in the neck, and obviously also from the possession or non-possession of the indications of the mammary glands. Female skins may be generally cut into the necks, but with male skins this could not be well done. Calf skins are packed as "all females" and "sortes"—one-third male and two-thirds female skins.

In waxed calf skins it is necessary to avoid the backbone, or, at any rate, its lower portion. As the neck is reached, the fibres of the skin render it more compact, so that it is allowable to get the back fold lengthways through a vamp or golosh; but on no account must the lower portion, near the butt, be cut down the fronts. At either side the back-bone the skin is also rather loose, owing probably to the prominence of the bone which this part of the skin covers, rendering the skin thinner.

The principles given in the early portion of this chapter, so far as they apply to wax calf, must be kept steadily in view in this method of clicking also.

The vamps for men's work being of a different shape to those for women's may be better fitted into each other —the golosh wing of the one fitting into the opening of the second.

Three qualities should be cut from one dozen of skins —best, seconds, and thirds. The skins should be sorted for substance, having the stoutest at the top, and arranged downward, with the lightest at the bottom. The cutting should be commenced from the back-bone, with the vamps or whole goloshes. If the latter, the patterns can be cut to lock in one with another, or with a narrow opening, and pulled open afterwards. The first method is preferable, as a rule. The cutting should be continued each side carefully, the quarters being secured nearer the edges, in conformity to the rule previously formulated—"to get the fronts and such parts as are subjected to the most severe wear from the best parts of the skin." Several patterns must be used in the process, in order to secure the various qualities in proper proportions. At the shoulders, shoes, or legs for strong boots should be got out. The remainder could be cut up for pieced goloshes or shoe quarters. In cutting blocked work, the start should be made from the back-bone, the back, or rather top, of the pattern lying towards the flank. By this means, if the direction of the lines of tightness are remembered by the student, it will be seen that the front would be tight down the centre of the pattern.

Under the older methods of calf cutting, and also of kip cutting, it was usual to "cast" the leather first, and to stretch it, and then cut out to the exact size required. This method, if properly performed, doubtless improved the wear of the boot; but it is very questionable if it improved the boot to such a degree as to compensate for the extra trouble bestowed.

Waxed calf and kip are sometimes, in some large factories, cast up by a competent man, several boys being employed under him to cut to his casting. By this means a great saving in wages is effected, though the work, as done, is not always of the highest quality.

Cordovan is purchased either in the form of shoulders, butts or sides, or bellies. In the shoulders the leather is tighter in the direction of an angular line of 45 degrees, with a vertical line drawn through the centre. At either extremity an amount of offal is found, and the shoulders are loose, more especially at the lower edge.

Cordovan is now mostly used for children's work, though a considerable amount of the material is con-

sumed in the manufacture of the cheaper qualities of ladies' work. Considerable judgment is required in clicking, as the leather is very often unlevel. It may be generally held in view, however, to get the larger sizes out of the stoutest of the materials, and the smallest sizes out of the lightest.

The butts or sides are tight in almost all directions, and particularly so breadthways. They are loose at the edges, the loosest portion being at the rump end of the butt. No set rules can be laid down for the cutting of this description of leather, other than the general principles frequently elucidated in the former parts of the chapter.

Bellies are only used for common work, such as men's slippers, etc.; there are but few good fronts to be obtained from them.

Great care should be exercised in cutting kips, as they are often very unlevel in substance. Being stout and tough, practically they have no stretch, stout men's and boys' work being cut from this description of leather. The hide may be cut either from the back-bone to the flank—that is, breadthways—or from the butt to the neck—that is, lengthways. It will usually be found best to start with a row of vamps from the butt, as with grain hides; though even here, to cut with the greatest economy, a quarter may perhaps have to be obtained. Great care must be exercised in getting out the work, in order that all parts match in regard to substance. When the vamps have been obtained of the quality desired, the quarters or backs should be got out. In getting out the vamps, the hide should be cut from the back-bone to flank for the start. The exact position in which the backs should be placed on the hide must be determined in a large measure both by the sizes of the patterns and of the hide to be cut. If a small pattern were used on the wide kip butt, it would be advisable to cut across the hide; but if a large pattern and a proportionally narrower hide were to be cut, the patterns should be dispersed in a direction along the back-bone, that part of the hide presenting the largest cutting area. In cutting kips many hidden flaws have to be guarded against. The leather is dressed with such a smooth face that there is some chance of many flaws escaping the observation of the clicker, which with a less finished surface he would readily detect. It must be the endeavour of the clicker to cut any small flaws into such parts as they do not affect the wear. Thus occasionally in toe-capped or

brogued work flaws may be worked under, economising the leather and doing no injury to the boot.

Most kips have the wider or butt end to about half the length and entire width suitable for vamps; others are best and stoutest lengthways, along the edge of the back-bone. Thus, with kips of this class, the methods previously described—of getting out vamps at the butt end, from back-bone to flank, and backs along the length of the hide—will be found most generally useful.

Some kips are useful for backs alone. In that case the backs must be cut to the length of the hide, starting from the butt, continuing along by the back-bone to the neck.

Crupp, or "quagga," is extensively used in imitation of porpoise or of white whale. It is a leather with a very smooth face, somewhat similar to cordovan. It is manufactured from that portion of the horse-hide immediately over the buttocks. Some of the cheaper qualities have a deal of horny substance in the centre of the material, and should be avoided, as they do not hold the closing stitches. In the better qualities of crupp this horn is not found, for this reason—that the hide is shaved down to it, and this is the cause of the beautifully smooth face found on the best qualities. Good crupp is tolerably stretchy, but the common qualities are altogether devoid of this peculiarity. In any case, careful cutting is to be recommended, and judgment must be exercised.

Satin hide is an American leather sold by measurement, in pairs, as grain hides. It has little stretch, except in the offal—consisting of shanks, bellies, and flanks. In cutting, proceed from the back-bone. It is advisable to get a row of quarters before taking out the vamps, the leather being more to be depended upon from four to six inches from the bottom. The vamps should never be cut too near the shoulder, as the leather at that part is liable to break or split in lasting. Being large in area, there is plenty of scope for clicking economically, more than one half the hide being good enough for vamps.

In getting out goloshes, etc., from patent calf, the same general principles apply as do the cutting of waxed calf. In cutting patent laced Oxfords, however, it must be remembered that a point of great importance in a patent lace shoe is the quality of the facing. Under some systems of clicking this part is cut into the worst of the material. This must be avoided, as it is of impor-

tance that the strain of lacing should not pull out the eyelet-holes.

In cutting court shoes the skin should be laid lengthways, so that the butt lies to the left and the neck to the right hand of the workman. This is necessary on account of the length of the pattern; and we have here a practical demonstration of the doctrine of the proportion of areas. The skin presents a smaller area at the butt when laid in the ordinary manner—i.e., narrow-wise—and it would be found to produce the work in a manner less economical than by fitting the patterns into a larger area, as is done by cutting the skin with the butt end to the left of the operator, or broad-wise in front of him.

In cutting seal patent the grain should always be cut so as to run straight to the toe, and not in a manner horizontal to it. The skin should be first got as square as possible by cutting quarters around the irregular edges, after which the vamps should be obtained in order.

The same principle applies to straight grain morocco, and to all leathers of that nature.

We have given general principles to guide the clicker, and those principles he must keep steadily in view in all descriptions of work. They will have to be modified to meet particular demands, but under no circumstances must they be seriously departed from.

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## QUESTIONS FOR CHAPTER VIII.

1.—State what you conceive to be the fundamental principles of all clicking.

2.—Discuss the relative advantages of heel-to-toe and tight seams in clicking.

3.—For what reasons are female skins preferred?

4.—What do you understand by the term "sortes" as applied to calfskins?

## CHAPTER IX.

### On Fitting and Closing.

Of all the processes of boot and shoe manufacture perhaps none requires greater care in manipulation than that of fitting. If the skiving is performed carelessly, no beauty in the finished upper can be reasonably expected, and unless the proper allowances for seams, etc., are carefully and minutely attended to the boot will not be of the shape and style the designs of the pattern cutter would have given to it. The method of fitting now almost universally prevalent is that of paste fitting. Some descriptions of cashmere and lasting goods are still fitted with needle and thread, but even in this department paste fitting is becoming increasingly prevalent. Before the parts of an upper are fastened together with paste, it is necessary that—at those parts where overlapping seams are to be formed, or where the upper is to be turned in—the leather should be reduced in substance by skiving. This operation may be performed either by hand or machine. If by the hand process the part to be skived has to be laid on a marble slab. This is necessary in order to ensure that a perfectly level skiving shall be obtained. If the surface on which the leather was laid were unlevel, of necessity the surface to be skived would be rendered unlevel also, in which case the difficulty of securing an even skiving can be readily understood. If skived by machine the process is accomplished by passing the part through a machine, bringing the leather in contact with either a fixed or a revolving knife.*

With different classes of work it is sometimes necessary to modify the method of skiving. Thus, with kips a clean cut should be taken, whilst for kid vamps some

* The mechanism of skiving machines, as also of sewing and other machinery, will be dealt with in an after chapter.

advise that skiving should be done with shorter cuts. A good process for stout work, and one which assists the closer to properly perform her task, is to plough a shallow furrow at the line which the seam stitches are to take. Thus the skiving is performed at the stitching points, and not exactly on the edge. This method gives a stronger seam with heavy work, but, of course, is not adapted to the lighter classes of goods.

Perhaps the most important consideration in seam closing has more relation to the description and size of the needle than to the description of thread or anything else employed in the process of machine closing. Thus it was that Mr. James E. A. Gibbs once said: "The needle does all the sewing, anyway. Give me a good needle, and I will do good sewing with almost any sewing machine." In every class of sewing machine the action depends upon the needle descending to its lowest point in the down stroke, then pausing and throwing out a loop, when it begins to rise from such lowest point. In fact, the ultimate action of the machine is dependent on the action of the needle. It is the needle which accomplishes the actual process, the whole of the mechanism being but accessory to, and for, its proper movement. Thus it is of the very first importance in seam closing that the needle should be of the highest quality and of the most correct form. The eye should be as large as possible, in order to take as large a thread as the size of the point will permit, and be smoothly finished. To assist the throwing out of the loop at the commencement of the rise of the needle on one side of the needle only, two grooves are cut thereon; on the outside a long, deep groove, in which the thread lies and works with a minimum amount of friction, whilst the inner and loop side has but a short groove cut near to the eye. These grooves should be as deep and well defined as the size of the needle will permit. Needles are made with round points, as the hand needle, for cloth work. For leather work the needle should present a chisel-shaped point, in order to better cut the leather.

The size of the needle in relation to the thread used is another matter of great importance. It would be idle to expect a solid seam from the use of a small thread and a big needle, because the thread, not properly fitting the opening made for it, would chafe and wear itself out very quickly. It must be remembered that the sole purpose of the needle is to pierce the leather, in order that the thread may be passed through it, and that of a con-

sequence the hole so made should be no more, but rather less, than the exact size to admit this thread. The aim must be to use as large a thread as the eye and point of the needle will admit of.

The following table showing the size of the needle to the silk will be found generally correct:—

| | | | |
|---|---|---|---|
| 2's | needle, | 12 or 14 | twist. |
| 1½ | ,, | 16 or 18 | ,, |
| 1 | ,, | 18 or 20 | ,, |
| ½ | ,, | 20 or 22 | ,, |
| 0 | ,, | 22 or 24 | ,, |

For glove or glace kid work, 0 needles and 22 silk should be used; for general kid work, ½ needle and 22 silk; for levant box calf work generally, 1 needle and 18 silk. If the work is of an extra stout nature, 1½ needle and 16 or 18 silk should be used.

For different classes of work the needles should be set in a slightly different manner. For heavy leathers the stitch requires to be perfectly straight, as follows:— ||||||, the needle to be set in a line with the arm of the machine, the chisel-shaped edge making an angle of 90 deg. with the table of the machine. For a good closing stitch for work of medium substance, the needle may be set so as to make a stitch inclined as follows:—///////. For lighter work the angle of the stitch may be still more acute.

When a plump stitch is required the flat-pointed needle is used; and when the stitch is to be sunk into the leather the twist-point may be employed.

But, besides a proper regulation of the needle, it is necessary to have a proper thread, in order that solid seams may be produced. Unfortunately, there is some slight disagreement among experts as to what are the essentials for a good closing thread. It will be our purpose to impartially consider the matter of threads and their adaptability for closing seams.

The indispensable conditions for a good closing thread are:—(a) That it shall be such as to resist the greatest amount of friction; (b) that it shall be capable of resisting a certain amount of lateral strain; (c) that it shall be such as to work smoothly on the machine.

We have to consider the merits of three closing agents —silk, linen, cotton. We shall endeavour to impartially consider as to how far they fulfil these three conditions. We will consider silk, first as regards its powers to resist friction.

The silk in common use for boot closing is prepared in

such a manner as to render its working through the thread guides of the machine very easy and smooth. Now in this consists its great merit, and whatever may be the truth as regards the working of a cotton or linen thread on a lock-stitch machine, it cannot be said that silk is worn in any damaging manner by the machine itself in the process of seam closing. Mr. Lascell has a very ingenious argument in the first page of his work, "King Cotton," showing the amount of friction the thread is subjected to in a Wheeler and Wilson machine before the stitch is landed in the leather; but as he does not state what the actual thread is which he assumes to so readily wear out under the machine, we must assume it is some other thread than silk, as practical experience has shown us that silk does not behave in the manner described by Mr. Lascell under a lock-stitch machine. So far as the withstanding of the friction of the machine is concerned, silk is perfect; and as there is no sufficient evidence to prove that English silk-closed boots, when properly cut and machined, rip within five to ten weeks, as alleged of American goods, we must further assume that the amount of resistance to friction possessed by silk is all-sufficient for the manufacture of boots and shoes. Evidence could be produced, if necessary, of boots which have been closed with silk having lasted for years without one stitch ripping.

The amount of lateral strain which silk is capable of resisting is shown by the following table of breaking strains of the various classes and sizes of silks:—

Black silk, No. 16.....will break at 5 lb. single.
Black silk, No. 18.....will break at 4¼lb. single.
Black silk, No. 20.....will break at 3¾lb. single.
Black silk, No. 22.....will break at 3¼lb. single.

White silk has a higher breaking strain than black silk, and yellow has a higher than white.

It is apparent from these figures that silk possesses more than enough powers of resistance to a lateral strain to render it amply trustworthy in the manufacture of boots and shoes.

Now for linen. It does not work on the machine so smoothly and easily as silk; its powers to resist friction are almost equal to silk, whilst its pulling strength is rather less than silk and about the same as cotton. Its chief detriment is not working easily through the thread-ways.

It is, however, with cotton that we have the most important arguments to consider. It is claimed for cot-

ton that it will work as smoothly as silk upon the machines, and that its pulling strength is quite sufficient for all the strains which a boot upper receives, as indeed it is. The great virtue, however, which is claimed for this closing thread is its powers of resisting friction. In proof of the immense advantage of cotton in this respect, Mr. Lascell has given the result of a series of experiments conducted by him, by passing a strand each of silk, linen, and cotton, to which a $16\frac{3}{4}$oz. weight was attached, through a piece of smoothened steel.

He lowered and raised the weight with each piece of thread tested until it parted, and he gives the following as his total results:—

He made six tests, the silk being carried through a total of 1,139 times before breaking; linen, 1,150; and cotton, 8,268 times, thus giving a tremendous advantage in this respect to the cotton.

Such are the facts, then, regarding the merits of the threads used in closing; and it must be said that, if cotton can be worked on the machine as easily as silk can be, it has every right and every prospect of superseding it; not because silk does not hold, for it does, but because cotton has all the elements without an abundance of superlative advantages beyond those which render silk such a capital closing thread. Cotton has strength enough, and immense powers of resisting friction; and it but remains to be seen how it behaves in the threadways of the machine itself.

Some closers—indeed, the majority—use a silk upper thread, with a linen thread in the shuttle. The thread of the shuttle, being harder than the silk top thread, tends to cut the latter; though, by a proper regulation of the top and bottom tensions, there is no reason why it should. If the bottom tension is so tight in proportion to the top thread as to let the shuttle thread lie in a straight line, it will almost invariably cut the top thread. A perfect lock-stitch should be tied, as it were, in the very centre of the material, or, at any rate, as near the centre as it is possible by the regulation of the tensions to place it.

The greater the disparity of the length of the needle and shuttle thread, the greater the strain, and consequntily friction, on the thread itself. Hence the importance of a proper regulation of the thread tensions of both top and bottom threads.

It may be here remarked that the non-success of seam

closing is not always to be attributed to the work of the closer. If the boots fall into wrinkles at the top of the stiffener, and wear the seam out, that is no argument that the material with which the seam was closed was unsuited to the purpose, or that the matter of the seam closing was in any way improperly performed. The arguments of the advocates of the use of cotton, admittedly strong ones, are weakened from the fact that the principal point which they instance at which silk is insufficient is the back of the boot at the top of the stiffener. Thus we are told that the heel seams give out in the "wrinkles formed just above the stiffener." Now, as a matter of common observation, it is known that if "wrinkles are formed just above the stiffener," not alone will the seam give way, but the leather itself will speedily wear out—thus the matter in such a case is not so much what material to use in closing the seam, as it is one of how to prevent the formation of the wrinkles. This depends upon the form given to the pattern; if it is cut correctly it should not wrinkle at the heel above the stiffener, thus abolishing the abnormal amount of friction at that point.

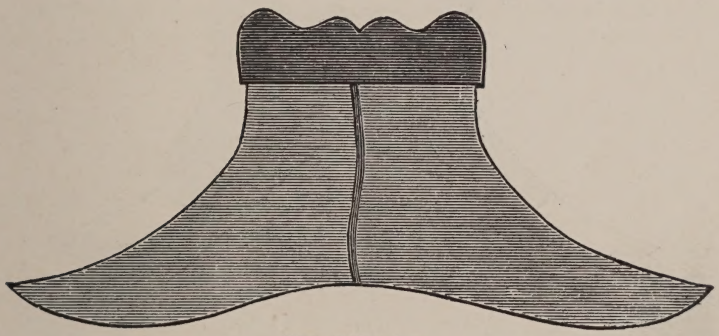
As best illustrating the actual processes of fitting and closing, examples of various classes of work will be taken and the methods adopted for each example explained. The fitting and closing of ladies' kid button boots, with worked button holes, will be considered first.

It will be first necessary to close the quarters at the back. This must be very carefully done, and care must be exercised to keep the stitching at an equal distance from the edge right along the line. If a devious row of stitching is formed, the back seam, when rubbed down and the quarters turned over, will appear lumpy and uneven, and will cause the boot to break sooner in the wear on account of the unequal distribution of the strain. If it is desired to "open-stitch" the seam, a strip of good lining should be placed up when the seam has been rubbed down, and a row of stitching placed either side of the seam at equal distances from it.

The next process is to bead the button piece. This is usually done by thin black skiver being placed round the edge or scollops of the button piece, between the fly and its lining. This is in order to give a neater appearance to the leather by hiding the roughness of the edge. The button piece lining is now carefully pasted on, and when dry machined. The button-holes are now worked either by hand or machine. If by hand the button-hole

must be punched, but if the process is conducted under the Reece machine (one of the best known button-hole machines now in use) the hole is both punched and sewed by the machine itself. The Reece leaves the hole unfinished at the end, and if no finish were added the working of the hole would soon pull out. Thus it is necessary to work a bar across the bottom of the button-hole by hand, as under the hand process; or the ends can be carefully drawn between the fly and its lining by means of a small hook, and fastened down with indiarubber solution. For better quality work it is advisable to adopt the former method.

The lining is now closed up the back, and the webbing

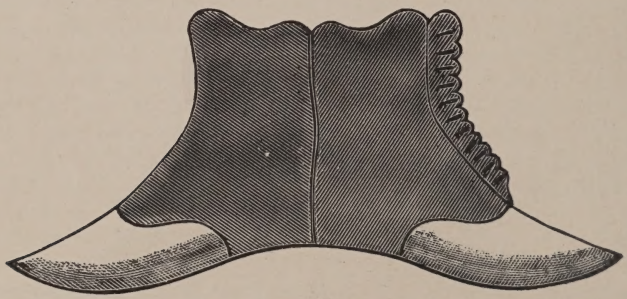


Closed Lining.

machined over the seam, which is then rubbed down flat. Paste on the top band, leaving at least a quarter of an inch for turning in; not quite so much would be required on the inside quarter to which the button piece is attached. When sufficiently dry, machine on the top band. It will now be necessary to attach the button piece to the quarter, and the button piece lining to the lining itself. In these processes two separate seams are formed, the button piece and lining not being attached by one seam. The lining up to this point being separate from the outside quarters, it is readily seen that this process presents no difficulty. Under bespoke methods of closing, the button fly lining is attached to the lining of the boot by felling; but, owing to the decadence of hand needlework in England, it is generally most advisable to perform the operation under the machine. If the felling is done indifferently it spoils the whole appearance of the boot upper, besides which it is always advis-

able when practicable to use but one process throughout the whole operation of closing. The front seam may be open stitched, as was the back, if it is thought advisable so to do. If, however, the seam has been properly closed with a proper size of needle and thread, this open stitch for ladies' kid work is decidedly unnecessary and clumsy, and should accordingly at all times as far as possible be studiously avoided.

The lining is now partially attached to the outside quarters. To further proceed: Lay the lining and quarters flat on the fitting board, fit the bottom stay, paste the quarters round the edge, and fit the lining on the outside quarter; now turn in the top band with a dull



Upper Ready for Vamp.

knife to the outside quarters as the guide; when dry, machine.

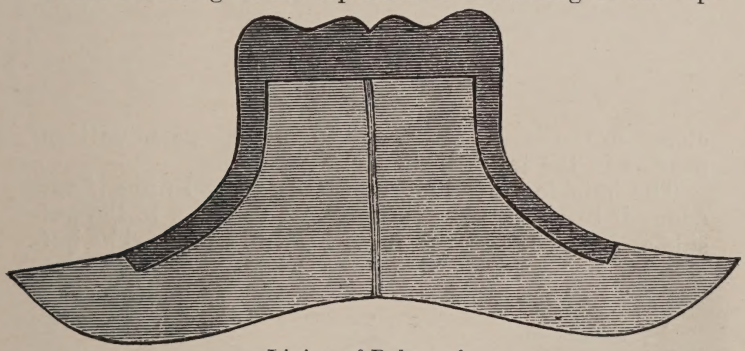
Thus, so far, the upper is in the state depicted in the above figure. The lining has been closed, the quarters closed, button piece attached to the button fly, and the two connected with the quarters and lining, the top band fitted and machined—thus uniting all the parts together, with the exception of the vamp.

Before the vamp can be fitted the lining must be seamed at the toe, and the button piece stitched or fastened to the under quarter. The lining is then pushed back, and the vamp, after having been skived and turned in, is fitted to the points indicated by the clicker on the quarters. When in a fit state the vamp is stitched on under the machine, and when the buttons have been attached the boot upper is completed.

It will be found necessary to whip the edge of the outer quarter to the button piece to about three inches, and for this reason:—When a boot is lasted, a strain

being placed upon the upper at the sides, it pulls all those parts which are not well fixed together out of their proper position. Thus, when a strain is placed upon the outside quarter in the process of lasting, it drags it away from the inside quarter, rendering the boot smaller at that part than the size of the last; for the strain being a temporary one, on the withdrawal of the last the two quarters again come together, but not in the former manner. To prevent this the edges should be whipped together as previously described.

In closing the quarters at the back a 1's needle and 18 silk should be used. If open stitched, ½'s needle and 22 silk. The stitching of the button piece to its lining should be done with ½'s needle and 22 silk, as also should be the stitching of the top band to the lining at the top



Lining of Balmoral.

of the leg. The vamp should be stitched on with ½'s needle and 20 silk. These remarks apply, of course, to machines run on the team system; it would not be practicable to change silk and needle for each division of the boot when one upper had to be done right off by a single machinist. In such a case a good medium size of needle must be selected, and a proper thread to fit it. The general sizes in such a case are given in a previous paragraph.

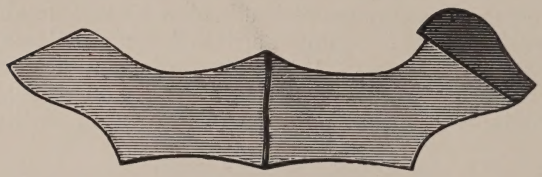
The fitting and closing of ladies' Balmorals does not differ essentially from the process adopted for a button boot. The minutiæ of the process, however, are different.

The quarters are closed at the back, turned, and rubbed down. The lining is closed at the back, and the facings and top bands are pasted, and, when dry, stitched to the lining, as shown in the preceding cut.

The quarters are now fitted to the linings, the facings

and top bands being turned in to the outside quarters with a dull knife. The toe of the lining is seamed, and the vamp fitted as for the button boot.

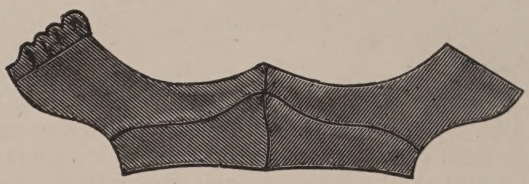
We will assume that the shoe to be fitted is to be goloshed and have stitched holes. In this case the lining must be closed at the back, and the button fly lining be closed to the quarter linings. The goloshes should now be fitted to the quarters, and the goloshes and quarters closed at the back. The button piece must now be



Lining of Shoe.

closed to the inside quarter, and the two parts will appear as in the following cuts:

The outside must then be fitted to the lining if raw edge; if turned in, the lining must be fitted to the outside and the edge turned in with a dull knife. The but-



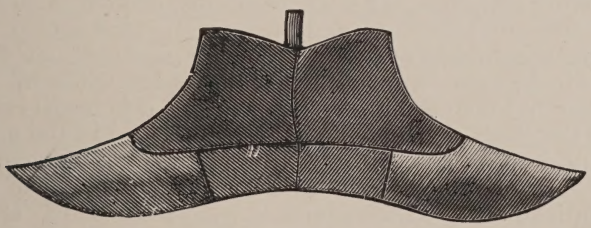
Outside of Shoe.

ton piece can then be stitched at its edge and around the top of the quarters. The button holes are then cut and stitched, the vamp lining and vamp fitted as in the lace shoe, and the upper closed and completed.

Close the quarters at the back, close the quarter lining at the back, and rub down the seams in the usual manner. If necessary, fit and machine the inside backstraps. Now machine rows of stitching to imitate the facing on the quarters, turn in the outsides, and, with the lining face downwards, paste the outside quarters, and turn in lining to edge of the outer quarters. When dry, machine round the edges. Now fit the vamp lining.

To do this, cut the stitching at the bottom of the facing, and insert the vamp lining between the quarter and quarter lining. Turn in the vamp and paste it to the marks on the quarter. Machine round the vamp; line the tongue and secure it by hand stitching, or by a row of stitching just above the vamp on the outside quarters. It is of importance that the bottom edge of the tongue should not make a thick bulge; it must accordingly be neatly skived, whilst its lining must not come to its extremity.

These different examples of ladies' work embody the main principles of fitting and closing in this department. If the student thoroughly comprehends the explanations of these examples and is able to creditably fit such work as has been here exemplified, other descriptions of work should present but few difficulties to him.



It is now necessary to consider the processes adopted in fitting and closing men's and boys' work.

The fitting and closing of a man's Balmoral on the flat will be first considered. The linings are seamed at the back, and the back leathers and facings fitted. Next the leg quarters are closed. Now fit the quarters to lining, inserting loops and turning in the facings and top bands to the outside leg quarters. Machine round quarters. Now seam and turn back goloshes and fit to the linings. Stitch through quarters. The upper now presents the appearance seen in the illustration. At this point in the upper's progress the eyelet holes should be punched, as this renders the task of eyeletting much easier.

It is next necessary to fit the vamp to the marks displayed on quarters. When dry, machine, and after brushing, etc., the upper is ready for the laster.

A far superior plan is to fit the upper on a block, this having the tendency to keep the boot upper, through the whole of the processes of fitting and closing, in such a shape and form as renders it easier to last and of the

desired shape of the boot. The process adopted is this: The linings are seamed, as in the former manner, and the top bands and facings fitted, after the lining seam has been well rubbed down. When dry, the quarters and linings are machined together near the edges all round The loop is fitted and the back band stitched; the quarters are joined just at the base of the facing, and the upper is almost ready for the golosh. Before placing over the block the lining must be seamed at the toe and the quarters laced. To this latter end it is preferable to punch the eyelet holes before fitting the golosh, as it does away with the necessity of stitching the edges of the facings, and, moreover, prevents the injury to the upper by twisting it about, in order to get the bottom eyelet in. It is in the method of blocking and machining the golosh that the distinctive feature of this method of fitting consists. If a whole golosh, after it is welted and seamed at the back and the quarters placed over the block, the goloshes are now fitted by placing them over the block, as on a last, to the marks indicated by the clicker on the quarters. By this means it is readily seen that the exact shape of the upper is retained in the manner desired by the pattern cutter; and this also renders the work of the laster so much easier and better of accomplishment. If the goloshes were seamed, of course the side seam would be closed before the golosh was fitted over the block. The goloshes fitted, when dry, are machined on a cylinder machine.

The principles of both men's and boys' work are the same, and it is accordingly only sufficient to exemplify the one in order to explain the other.

Hand closing is now rarely adopted for short work, and even for long work machines are now in use which produce work for all practical purposes equally as good as under the old hand process. A remnant of the old method still remains among the West-end closers. Under the old methods the closer in reality acted the part of the present-time clicker. The stuff was merely cast out, and he had to cut it to the exact shape, and fit it to the last as well as close it. In many best shops the same methods are still employed, with the exception that instead of closing by hand the machine process is adopted. What advantages this method possesses over the more modern system when well conducted no one save the leather seller can comprehend.

## QUESTIONS FOR CHAPTER IX.

1.—Describe the different "skives" that may be made, and their relative suitability for differing classes of work.

2.—Give a table of needle sizes and threads suitable therefor; name the classes of work to which the combinations are suited.

3.—Discuss the relative advantages, etc., of silk and cotton as closing agents.

4.—Describe the process of fitting a lady's button boot.

## CHAPTER X.

### Rough Stuff Cutting.

Authorities:—For the raw material, Proctor's "Text Book"; Evans on "Butt Tanning"; Davis's "Leather Manufacture."

In different countries different divisions of the hide are made before tannage, but the divisions usual among English tanners are:—

(a) Butts—the best and thickest.
(b) Shoulders—lighter, from between cheeks and butt, across neck.
(c) Bellies—light, from either side.
(d) Cheeks—rough leather, principally offal.

The divisions of the hide are shown in the following diagram:—

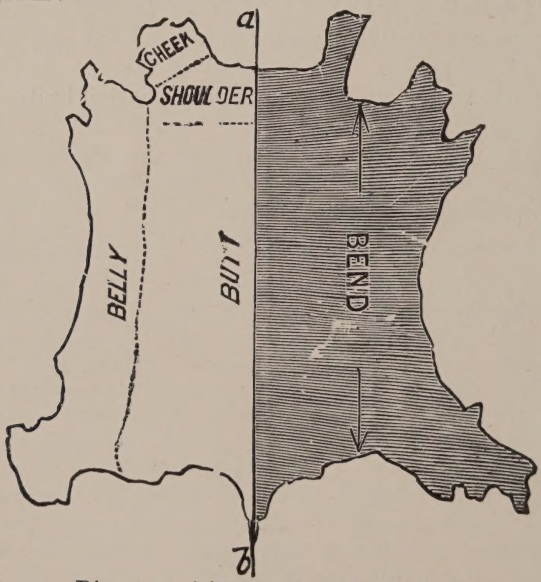



Diagram of Hide, after H. R. Proctor.

(The shaded part represents the hide cut half way, when it is termed a Bend.)

If the hide is divided completely down the centre, as in a line from A to B, each half is then termed a "bend."

It is in a form such as the above that the hide is submitted to the action of certain tanning agents, and thereby converted into leather. Of course, hides are of different qualities, and it depends upon the quality of the hide, and of the particular tanning agent applied, and the method of tanning adopted, what quality of leather is produced.

The same general principles of cutting, however, apply with equal truth to common leather as to that of better quality, the aims being, first, to get as much out of the parts as possibly consistent with the purposes to which the leather will be subjected; and, secondly, the avoidance of waste.

These general principles we shall now proceed to consider. The first division of the hide, and the most important one, as was noted previously, is the butt. The first consideration, and which should determine the method to be employed in cutting a butt, should be its weight. A heavy butt, as a rule, can be ranged up much closer to the offal parts than can a light one. For those parts near the offal in a light butt, which, on account of their want of substance, would be unfit for long soles, from the very fact of their possession of substance, though near the offal, would nevertheless be suitable for soles for common work, when cut from a butt of heavy weight. Thus it is seen that it would be possible to range up a butt much farther in the case of a stout, heavy butt than in the case of a light one.

In cutting up, certain principles should be kept in view, and these principles are as follow:—

(1) To so arrange that all soles should, as far as possible, be most pliable and most yielding lengthways.

The reason for this is obvious. The most strain upon the sole of a boot devolves upon it from the heel to the toe. In walking, as has been shown in the chapter on anatomy, the constant effort of the foot is to lengthen and to spread itself, but most of all to lengthen itself. It follows that, in this action of lengthening, extra strain must of necessity devolve on the boot sole lengthways; besides which, as additional reason that the sole should be most yielding in the direction indicated, we have to remember that a boot should be so constructed as to give as far as possible to every action of the foot, and to none less so than the action of lengthening. Again, if the

leather is cut to yield most across, it is seen that the chances of spreading over—which it is the constant endeavour of the manufacturer to avoid—are greatly increased.

(2) To arrange that the best leather is placed where most wear devolves.

This is a self-evident proposition; but it is nevertheless a most important one. To this end toe sole-ranges may be cut—that is, ranges arranged that all soles are cut one way, and not in two opposite directions, locking in at the waist, as is usual. This adaptation of toe soles is necessary when the range is good at one edge and indifferent at the other. By cutting the soles all with the toes towards the good edge and the heels towards the other, this second condition is fulfilled. It is apparent to everyone that a good quality of leather, though perhaps desirable, is not so absolutely necessary under the heel as at the forepart. Further, when this second principle is remembered, it is seen that it is allowable to range up to admit of soles being cut minus a part of the heel portion, such soles being termed "pieced," because the deficiency at the back is supplied by "piecing" any inferior quality of leather to the sole under the heel. This idea generally prevails in practice in men's work, more soles being cut "pieced" for manufacturing purposes in this department than in any other manner.

(3) That in arranging the sole patterns and knives, in cutting, the endeavour should be made to fit the joint of one sole into the waist of the second.

By these means waste of leather may be avoided, and, the curve of the joint usually corresponding in contour

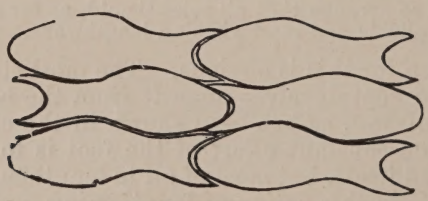


Diagram of Whitton's System.

to the curve of the waist, the condition is not hard of fulfilment. It must, however, be remembered that the shape of the sole pattern should not be sacrificed in order to secure this economy of cutting: for, however advanta-

geous it may be to secure this economy, it is of infinitely greater importance that the soles should be shaped to allow of the healthy action and comfort of the foot.

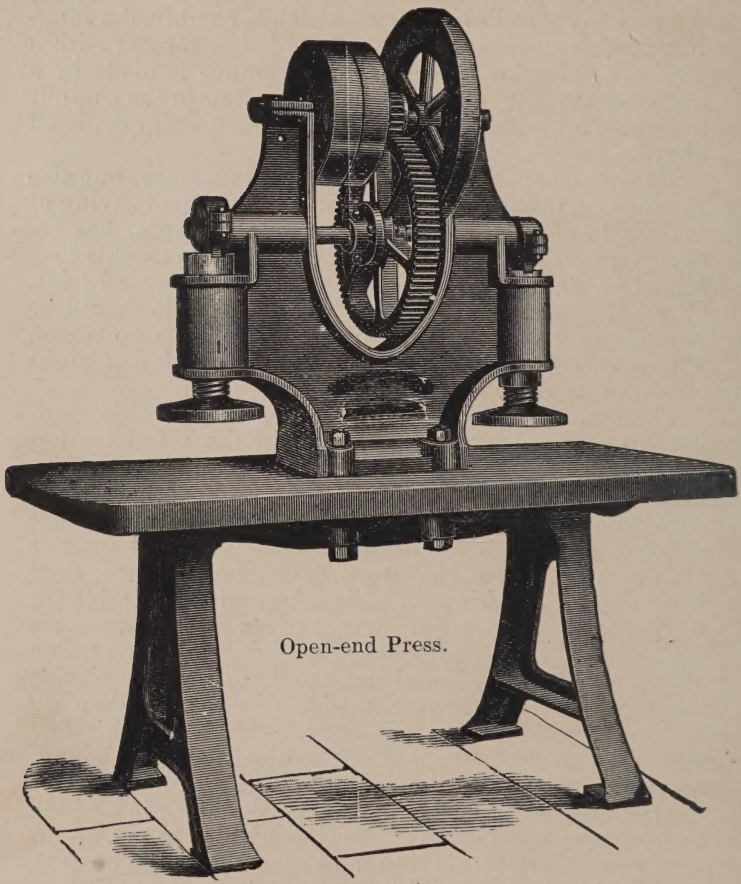
This third principle has been the subject of a patent. A press has been devised with which is combined a ranging machine. Instead of the butt being ranged with a straight knife, as is usual, the severance is made by a knife with a wavy contour, corresponding to the contour presented by a number of soles, in a manner as depicted above.

By this means not only do soles fit into soles, but also ranges into ranges, with the result that a great saving of leather is effected. The idea, though simple, has received a very practicable embodiment in the machine referred to, and is worthy in every way of extended trial. What it is possible to cut by this machine it should be possible to do by hand ranging, and there is no reason why a butt should be invariably ranged with a straight cut—at any rate, for cheap work.

The first process in "rough stuff cutting" is the ranging up of the butt. Of course, in the retail leather trade, soles and whatever parts are required are very often cut direct from the butt, but we have here to do with the process of boot and shoe manufacture, under which such system would be ruinous. Several systems are prevalent in ranging up. Some, for instance, start from the neck, taking off wide "first cuts" suitable for slipper soles, and next ordinary ranges. This process is continued to the rump, when those thick parts are taken off as "edge pieces," and used perhaps for toe soles or top pieces. Sometimes the edge pieces are taken off first, and stout ranges cut next. Probably this last method is most general. Each method possesses advantages of its own, and the general requirements of a particular method of manufacture must determine which is the most advantageous. Butts may also be cut up for hand-sewn work by placing long soles across the breadth of the butt in a straight line. This method gives a wavy contour to the edge, into which the second row may be economically fitted.

If the leather is to be used for machine-made or riveted work it will next be wetted and rolled. More care should be exercised in these operations than is usual. The leather should be wetted in clean water and not in any dirty liquor that may be to hand. The water should be allowed to thoroughly permeate the leather, as a partial wetting is conductive to the production of

stained soles—a result certainly not to be desired, especially when so easily prevented. By wetting the leather before making it up into the boot, an amount of foreign

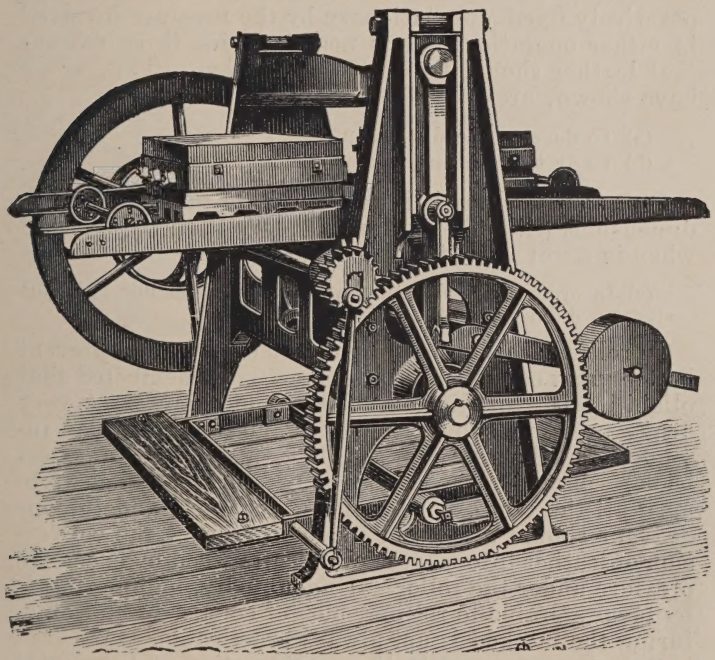


Open-end Press.

and useless matter is removed from it. All kinds of substances are occasionally worked into the back of the butt in order to increase the weight; and under this process of wetting a large proportion of these adulterations are removed. Further, its absorbent proportions are reduced by this process in conjunction with rolling.*

* It should be here remarked that leather should not be put under the rollers wet, but allowed to drain and get partially dry first.

If a small section of tanned leather be viewed with a high power under a microscope whilst in a dry state and it is then compressed, its fibre will be seen to be broken, and it will possess no compact solidity. If, on the other hand, a piece of leather be viewed under the same conditions as to pressure, etc., but wet, it is seen to retain its homogeneous nature throughout, not one part being viewed as separate and severed from the main particle.



Closed-end Press.

We have reason to believe that in wear, under the same conditions, the same process takes place as is seen under the microscope. The water appears to swell and bind together the fibres of the hide, and the leather, when hammered or rolled whilst in a mellow condition, appears to have solidified: thus accounting for the fact that when leather is properly wetted and rolled, its wearing properties are far greater than when those operations are neglected or carelessly performed.

If a sole be attached to a boot without previously having been wetted and rolled or hammered, its wear will

be rapid and of the nature of crumbling. This is an observation of common experience. If, on the other hand, a sole be well wetted and rolled or hammered, its wear is greatly prolonged, and is of the nature of structural destruction rather than of particular crumbling. Under the wetting process the leather is brought to its full dimension; and whilst at its full dimension, by rolling, or better by hammering, its dimension is rendered comparatively fixed and stationary by the pressure involved in either operation. It is necessary for three reasons that leather should be wetted and rolled. Two, as we have shown, are—

(a) To develop the dimension.
(b) To fix that dimension.

But, inasmuch as it is impossible to properly fix the dimensions without structural damage to the leather but when in a wet state, the third reason is—

(c) In order to render the two foregoing possible, without structural damage to the leather itself.

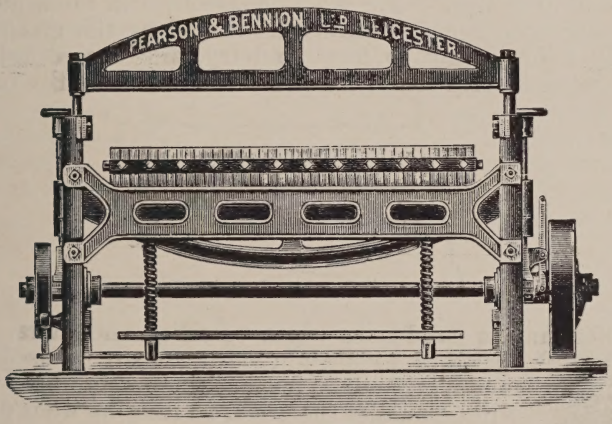
In rolling leather, care should be exercised to prevent its too great compression. It must be remembered that pliability is a quality in a boot, and therefore a very heavy pressure should never be put upon leather intended for the soles of any but the very commonest boots. A moderate amount of pressure is sufficient to meet all the requirements of most leather, and the endeavour should always be made to prevent the conversion of leather into what is practically wood by excessive pressure under the roller. Undoubtedly, hammering is by far preferable to rolling, but, of course, in manufacturing the method is not always practicable.

Before we proceed to the consideration of the actual division of the leather into the necessary divisions for boot and shoe manufacture, it is necessary to remark that insoling and stiffeners of leather are not usually wetted and rolled. Sometimes the shank ends of the bellies are rolled, in order to enable them to be cut to the best advantage. There is no good reason why insole leather should not be wetted and rolled as outside leather beyond this—that if bellies be cut in a moist state under the press, after the insoles dry, they may sometimes shrink to the extent of fully one size. Obviously, this is a disadvantage, but it is hardly an unconquerable one. The leather could be wetted and rolled, and allowed to thoroughly dry before being manipulated under the

press, when the obstacle mentioned would be entirely removed. As an example of this, it may be mentioned that in hand-sewn work the insoles are wetted, blocked, and allowed to dry before being finally pared into shape.

We have now to consider how the three principles we have laid down are practically applied in the actual division of the various parts of the hide into soles, top pieces, etc.

We have said that the butt is ranged up. This is




Revolution Press.

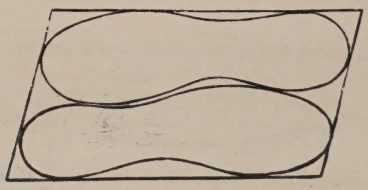
strictly so only when a closed-end press is used. If the open-end press is used, there is no need for ranging.

From these ranges, according to their width and quality, may be cut middle soles, long soles, and top pieces. Presuming the quality and width correct for cutting, say, men's long soles, we will consider under what method our principles could be fulfilled. The method that would most aptly meet the whole of the conditions would be to cut the soles across the breadth of the range. The soles should be cut a trifle on the slant, the width of the range being less than the length of the sole, to properly admit of this. By placing the knives in this slightly slanted direction, the soles fit in better at the waist, and so fulfil the third principle. In cutting "springs" for hand-sewn work, the range should still be less in width than the length of the sole, and the slanting direction adhered to as in the illustration (page 102).

If many pairs of soles of one size are to be cut, it will

be found preferable to get all for one foot first, and the corresponding number for the other foot next. The knives under these circumstances, in many instances, may be made to fit in much clearer than by the usual method of alternation.

Inner soles for hand-sewn work are best cut from the shoulder, or from the first cuts of light, mellow butts. If cut from hard, horny leather, the sewing can only be performed in a very unsatisfactory manner and with great difficulty.* For machine-sewn work, great power being exercised in pulling the thread by the machine, the stitch is not so hard to bury, and accordingly a harsher description of leather can be used for the inner



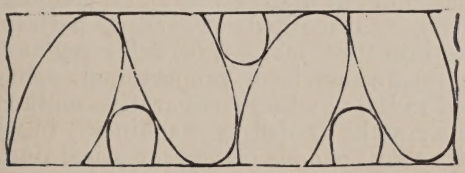
soles than in hand-sewn work. Bellies, shoulders, and the light parts of Australian sides can all be used for inner soles and stiffenings for machine-made work. In cutting bellies up under the press, no ranging up is practicable, or, at any rate, advisable, as in the case of the butt. More skill is required of the rough stuff cutter in manipulating uneven leather than in the case of even ranges. No definite system can be laid down that shall meet every demand of utility and economy in the cutting of bellies under the press; but it should be remembered that stiffeners should be cut in with inner soles; for, where the inner sole knife will not fit into advantage, it is often possible to advantageously run in a stiffening. Greater economy of leather can be secured by the use of several sizes in the knives, but it has to be considered which it is most profitable to economise—the leather or the man's time.

Shoulders should be ranged up, crosswise, before cutting under the press. Good inner soles for men's and boys' work should be cut from shoulder; they would, as a rule, be too heavy for ordinary ladies' work. When

* If the leather is harsh, in sewing in the welt the soles would break into one another, and at best, under such circumstances, no solidity could be secured.

ranged, the inner soles would be cut in the direction slanting and lengthways. When any leather is left at the edge not wide enough for an inner sole, it may be utilised, as a rule, for a stiffening. Kip sides, though too harsh for machine-sewn work, are probably the most economical for cutting under the press, being squarer and better shaped than either the bellies or shoulders. It is hardly necessary to say that the advantage of shape cannot be estimated too highly in considering the actual production or realisation under the closed-end press. They should be ranged first, and the inner soles cut in the same direction as for shoulders. For cutting irregular-shaped leather, the open-end press is to be preferred.

In cutting top-pieces from ranges, several methods of placing the knives may be employed consistently with economy. As illustrations will best display our meaning in these matters, the following diagram is submitted



as possessing the advantage of economy. When a range is of an inferior quality, clumps or middle soles may be cut therefrom, in connection with lifts. A system is in vogue, of which an illustration is here given, by means of which lifts are cut from the triangular portion left when the middle soles are taken out in two opposite and slanting directions.

Lifts for hand-sewn work may be cut from shoulder or from narrow first cuts. Australian sides are probably the best leather that can be used for building heels under the machine processes. By the use of this leather light weighing heels, well welded together, with a diminished liability to crack, may be produced. The leather is also used for common boot soles, and more especially for middle soles for clumps. It is found advisable, under some circumstances, to cut both lifts and clumps together, the same method being employed as for the cutting of an inferior range.

## CHAPTER XI.

### On Grading Upper Patterns.

Authorities:—Soule's "Pattern Cutting"; Hannibal's "Last Fitting and Pattern Cutting"—The many articles contributed to the trade journals by Mr. Edward Swaysland are the most valuable.

It has been thought desirable to add a chapter on grading methods. All methods of grading patterns resolve themselves into three classes: (a) arbitrary and shifting methods; (b) geometric or proportional, sometimes as well called radial; and (c) comparative methods.

Patterns may be graded by machinery, in which case of necessity they are done on mathematical lines, though in the Hartford Grader a considerable latitude is given for the embodiment of the ideas of the person setting the machine. That is to say, the patterns on the grading may be pitched one way either less or more than another.

The mechanical principle embodied in the machine is that of the pantograph, and that found in the proportional compass. The proportional compass is a mechanical grader of which we shall speak later, and is itself founded on Euclid's fourth proposition in the sixth book —that similar triangles have their corresponding sides proportional.

This proposition should be thoroughly studied by the student, and if he fully comprehends it he has the whole of the theory of mechanical grading at his finger tips, and will soon find numerous methods for the practical application of the theory.

The arbitrary and shifting methods, such as the 16th, all round and grading with fixed allowances for size and size, and such methods as Mr. Hannibal's, are purely rule-of-thumb, though useful (especially Hannibal's) in the discreet hands of competent men.

The geometric or radial methods, first given by an American writer of the name of Soule, have been so fre-

quently described and so frequently referred to (without acknowledgment to Mr. Soule) that no necessity is placed upon us to describe the method here. Its failure to produce perfect sets of patterns without after alteration or modification of the data originally given, and the embodiment of which in the pure form alone constitutes the method a scientific one, is well known, and needs no emphasis here.

The comparative method is that of grading a set between the two extreme patterns of the desired number. That is to say, if a set of patterns were desired from 2's to 7's (half sizes), the patterns required for the conduct of the system would be the 2's and the 7's. Radial lines could be drawn about four in number, and at corresponding positions on each pattern.

The following plan will be found to answer the purpose:—Measure up the back of pattern from corner of heel a distance equal to a fourth of the height of the back of the larger pattern, and draw a longitudinal line from this point, traversing the whole length of the pattern, and emerging at the point of the toe. Treat the smaller pattern in a like manner. Now draw three lines angular to this longitudinal line, and at fixed degrees from it.

The method of grading is as follows:—Draw lines through the outline of the pattern from a spot on the longitudinal line at two-thirds of its length from the toe end. Let all the lines cutting the outlines of the patterns converge to a common centre.

Now divide the interspace into the required number of intervening sizes. In this case we arrive at the required number as follows. Write down the figure 2, then represent the intervening sizes by dots until the 7's size is reached, when write the figure 7. Now with small numerals number the dots, and you get an appearance as here:—

2 . . . . . 7
1 2 3 4 5 6 7 8 9

and nine intervening sizes are indicated. To get nine sizes necessitates the division of the intervening lines into ten equal parts—one part more than the required number of intervening sizes. This rule of adding one division obtains, of course, whatever may be the number of the intervening sizes, whether less or more.

This space may be divided in several ways; some pattern cutters divide the space by trial. This can be done

with comparative accuracy when the sizes required are of an even number and not many. In the case we have here the number of divisions is too great for such treatment, and the employment of some more exact method is desirable.

The sizes may be indicated by the use of set squares. If this method (a rather long and tedious one) is employed, it would be as well to use a pattern-grader such as is sold by Mr. Duckenfield, of Northampton, to indicate the divisions on the working angular line. The plan adopted would be this:—From the point of any one of the lines dividing the interspace, set up another line at any angle to it. Take any convenient divisions in the grader, say, the quarter-inch, and mark on the line so set off the number of the intervening sizes required plus one, and then by means of the set squares join the last division of the set off line with the extremity of the intervening line. Draw lines parallel to this line through the points given on the set off line. Thus will the intervening sizes be indicated. Continue round the pattern likewise, and a complete stencil will result.

A method very much quicker and generally more accurate is to divide this intervening space line by means of the proportional compass. Certain divisions are seen to be marked upon it; there is also a sliding nut, with a line scratched on its surface. If the nut is slid along the slide until the scratched line corresponds with the figure 2 marked upon the side of the compass, the top space on the compass, when its legs are opened, will represent exactly one-half of that represented between the opening of the lower legs. If it were required to divide a line into two equal parts whilst the compasses were so set, the only thing to be done would be to measure the length of the line required to be so divided, and move the lower legs out so as to exactly include that length; then, reversing the compass, exactly one half of the length of that line would be given by the top and smaller legs of the compass. So if the requirement were different, and ten divisions were wanted instead of two, the nut would be slid to the point marked 10, and the instrument used as before.

This method of grading on the comparative basis with a proportional compass presents to my mind the readiest and most effectual mode of grading that I know. So far as I know, the system was first called by this name of "Comparative" by me at a lecture given at Northampton about 1887.

## CHAPTER XII.

### On Bottoming by Hand and Machine Processes.

Authorities:—There are notes on hand-lasting in Hannibal's "Last Fitting and Pattern Cutting"; Mr. Swaysland has contributed many articles of value in the trade journals; the matter of lasting is discussed, too, by Mr. Brophy; and there is much interesting information on machine methods in the series contributed by Mr. A. F. Randall to the "Boot and Shoe Trades Journal" of 1892, but of any organised attempt to state the whole bearing of this subject there appears to be none other than by early writers, such as Rees, now hopelessly out of date.

Bottoming, or the processes by means of which the bottom stuff is attached to the upper, may be broadly divided into two classes:—Hand-made work and machine-made work, these again being subdivided as follows:—Under the first division, pump work, welt work, pegged and riveted work. (Although the last two sections, owing to the extensive aid of machinery, may now be more properly placed under the heading of machine work, still they are inserted in the first division as being possible by hand, and at one time practised as such, though now very rarely.) Under the second division: Pegged, riveted, machine-sewn, standard-screwed, and machine-welted work.

If durability is the virtue most desired in the boot, then, with good material, solidity of workmanship is of the first importance. If, on the other hand, style, fit, and comfort are the chief points to be considered, then certainly "lasting" is the most responsible operation in the process of making. It is becoming a recognised fact that the much abused laster is not entirely responsible for this operation; the last maker, pattern cutter, clicker, and closer, all in degree contribute towards the success of the work, and are therefore in some degree answerable for it. Hence it can be seen at once how highly essential it is that the principles of lasting should

be properly comprehended by these different workmen. The last maker must form his last of a good shape, or the good appearance of the boot made upon it will not be obtained. The pattern cutter must not cut his patterns too short, or the boot when lasted will have a dragged and bruised appearance, besides putting an unfair strain upon the seams of the upper. Patterns should not be cut too tight in the heel, or the formation of diagonal wrinkles from the throat towards the back of the heel will ensue. With regard to the part the clicker performs, it simply depends upon the quality of the clicker —the better the clicker, as such, the better for the closer and the laster. The closing determines to a large extent the good or bad results of lasting. It should be done with the intention of carrying out the ideas of the pattern cutter, presuming they are right, and this intention should be continually in the mind of those having the management of the fitting and machine room. The laster should take care to see that the uppers are properly machined before attempting to conduct his own process. To judge whether the upper is fitted properly or not, the vamp should be slightly increased in the centre, and, holding the upper at the toe at this creased point and at the heel, by placing the fingers up the back inside the upper, any error in the fitting or machining may be readily detected.

In lasting, care is not only to be taken in order to get the seams of the upper straight, but also to set the "draught." By the draught it is meant that the boot should sit clear from heel to toe when made, and in such a manner that it shall wrinkle as little as possible in the wear. This is secured as follows in the manufacture of hand-sewn boots and shoes*: Place the upper on the last so that the back part is raised. (This process is sometimes called "horsing.") Fix the upper to the last by driving a tack in at the centre of the toe, also one at each corner. What are called draught tacks are now fixed—one at each side about one inch from the end. The lasting of the upper down to the forepart of the last is now proceeded with, the direction of the pull being towards the toe. The upper is now drawn down behind with the pincers by means of a piece of leather which has previously been placed inside the back of the upper, and

* In lasting hand-sewn, a peculiar kind of cube-headed nail is used. The "tacks" are driven about half-way, so that they are easily withdrawn in sewing.

which acts in much the same manner as a shoehorn. The heel and waist are now lasted, any fulness being worked into the forepart, the inside waist being lasted in very strongly behind the joint to lessen the possibility of wrinkling at that point. The forepart is next re-lasted; after which the fulness at the toe is carefully gathered in, plenty of tacks being used, and the toe nicely tapped into shape.

It has been seen that in lasting for hand-sewn, tacks are driven in half-way to secure the upper temporarily, and are withdrawn while the boot is being sewn; but in lasting for machine-sewn or riveted work small tingles are used and driven home, the iron last or iron-plated last used in manufacturing serving to clench them on the insole. This tingling is necessary because there is no intermediate sewing, the out-sole being placed in position by blinders, preparatory to the machine-sewing or riveting. With the exception of this tingling, lasting for machine work is followed out upon much the same lines as for hand-sewn work, but there is no possibility of that continual re-lasting of the upper that is common in hand-sewn work; and, consequently, the pincers have to be used upon the principle of one pull, one tingle, so that the better the upper fits the last, the better the lasting.

It may be here remarked that in all the processes of lasting, the fulness should be lasted, as common sense would direct, at the fullest parts of the last, namely, the joints, and not, as is too often done, at the narrowest part of the last—the toe. This latter method of lasting is a common cause of "piped" toes, and should at all times be carefully avoided.

There certainly could be a modification of the hand-sewn method, where tacks could be used and re-lasting performed, and no necessity for tingling, but the operation of lasting would be a longer one than it is at present, and would constitute an "extra" from the laster's point of view, involving as it does more care and trouble. The modification mentioned is that of "bracing." Bracing is regularly resorted to where riveted and pegged work is entirely made by hand, and consists in sewing the upper to the insole with a single thread, using an overcast stitch. This method, although it takes more time, is a most decided advantage over the use of tingles, and can be specially recommended for at any rate the best class of machine work, where the advantages to be derived from it would not be counter-

balanced by the additional price it would entail. In the preparation of work to be welted by machine this method of bracing is often resorted to in order to still further avoid tacks and tingles.

Many attempts have been made to invent some method of expediting the process of lasting by the help of machinery.

The object of machine lasting appears to be to pull over the edge of the last a certain amount of upper, and then to fix it to the insole. This, unless modified by the degrees of pull given to the pincers, will never give satisfaction in wear, because it is against the principles of lasting, which, to ensure a clean and good wearing appearance, necessitates the pulling and straining of the upper in certain different directions, according to the part which is being pulled, and it requires a constant watchfulness to see that such aim is accomplished, otherwise the work will never give complete satisfaction.

Many makers of lasting machines have grasped this, and have become less ambitious with regard to the design of the machines. In some lasting machines originally made with draw pincers, these pincers are now abolished, the actual pulling over of the uppers being done with hand pincers, the machine acting by pushing the last into the upper and blocking in the stiffener and closing in the difficult pleating at the toe. Machines of this character appear to be of more utility for use with the machine welting plant. A lasting machine for ordinary Blake-sewn work, to be of economic use, must do more than this. It must, in addition to the things already enumerated, fix the upper over the insole in an expeditious manner, and the truest method for the solution of this would seem to be that exemplified in machines such as the Consolidated Hand Method and the Sinning. And so we get two orders in lasting machines, which are stated as bed machines, i.e., machines of the general character of the first stated, and pillar machines, having the general characteristics of the second.

There is, however, one method of lasting for the machine that deserves more than passing notice, especially as the principle involved in it has now become a feature of more than one lasting machine. It is the patent of Mr. Hannibal.

The following excerpts descriptive of the process are taken from the "Boot and Shoe Trades Journal" of December 3, 1883:—

Iron lasts are still used. . . The centre of the sole of the last is taken away to admit of a layer of butt leather, ¼-inch in thickness, being substituted for an equal thickness of iron. . . . This layer of leather is capable of holding tacks for the convenience of lasting. . . . The upper is drawn over and tacked at the toe. . . . The lining of the upper, from the joints forward, is now drawn over separately, and is simply laid down upon the inner sole and fastened in its place with a little paste. . . The front toe tack is withdrawn, and the outside of the upper turned back; a strip of canvas, cut on the cross, and prepared with a strong adhesive rubber solution, is taken, and centred at the toe so that half its width is above and half below the edges of the last. A sharp pull at the ends of the strip causes it to assume the contour of the last, and to take the place of the side-lining and inserted "puff-piece" at the toe. That portion above the line of the last needs only a little pressure to cause it to lie flat on the insole, and the application of a warm metal roller secures it thereto. The outside of the upper is now brought into position, and, the tack at the end of the toe having been replaced, the lasting proceeds. . . . When the lasting is complete the heated roller is passed lightly all round the edge, pressing irregularities down and completing the process. The tacks are then withdrawn, and the bottom filled up with a thin strip of solutionised felt. Any unevenness is next pared away, a short shank is inserted, and the boot is ready for the sole.

In all ordinary boot work thread has always been most in favour for securing the various parts of a boot together, because of its ensuring a greater degree of flexibility; hence the popularity of sewn work in comparison with pegged, screwed, or riveted work—it is only in strong, heavy and consequently stiff, work that the latter methods are valuable.

The seams formed by a thread are of two kinds, viz., horizontal and vertical. An example of the horizontal seam is shown in pump work, and of the vertical seam in Blake machine-sewn work.

The horizontal seam gives the greatest flexibility, the working of this seam in wear being (so to speak) on the flat; and seams generally especially accommodate themselves to this kind of movement.

The vertical seam, per contra, is stiff, because the action it is subjected to attacks it in a different way; and the strain being greater, vertical seams require either a very stout, strong thread (as in the Blake-sewn) or, if the stitch is shown as it is on welts, it requires a larger number of stitches to make it solid in comparison with the horizontal. It is partly because of the machine-sewn work having a through vertical seam from insole to outsole that causes it to be stiffer than it otherwise would be, although much is due to the use of tingles and bad insoling. In pump work it is the use of the hori-

zontal seam that gives to that class of work much of the remarkable flexibility it possesses. Where an insole is required as well as an outsole, it is the combination of both seams* that gives the most pliancy consistent with strength. A description of the manner in which these two seams are combined will now be given.

Bottoming on the hand-sewn principle, as it is called, is acknowledged to be the best way in which boots may be made, and as an explanation of that process will give the best idea to the student of the manner in which bottom stuff is attached, and enable him to better understand more brief descriptions of the other methods, hand-sewn bottoming will be treated first, and a description of a sample of welted work given as a type.

The principles of welt work are used in the construction of medium and stout work—ordinarily speaking—although they can be, and are, applied in the making of very light work also, and are as follows:—A strip of leather—the welt—is attached to the material forming the upper and to the inner sole by means of a sewn horizontal seam. The outer sole is then attached to the welt by means of a stitched vertical seam. The stitches of both seams are formed of a thread composed of strands of flax for light work, and strands of hemp for stout work.

After the bottom stuff has been wetted it is fitted, i.e., the flesh is skived off, the grain scraped away, the split-lifts prepared, and the stuff hammered—the split-lifts being turned and hammered into the shape of the seat of the heel. Insoles are blocked to the last and fixed with tacks. While these are drying the threads are made. This little operation consists in casting off a certain number of strands of hemp or flax of the necessary length, and then twisting and waxing them. The proportion which the thickness of the threads bears to the work in hand is guided by practical experience—from ten to twelve strands of hemp forming a sewing thread for ordinary work, and seven to nine strands making up a stitching thread. When the insoles are dry they are pared to the shape of the last, and then feathered, and the holes made for the sewing thread. Feathering consists in levelling the edge of the insole all round, and then taking out a rebate from the edge, the width of the rebate being proportioned to the stout-

* The word "seam" is used here as meaning two or more substances held together by means of a thread passing through them.

ness of the work. The length of heel having been marked off, and the insoles prepared, the stiffeners are put in, and the upper lasted. The principles of lasting having been considered previously, the description need not be here repeated. When the lasting is accomplished the boot is ready for sewing in the welt. In sewing the boot is held by the stirrup, so that the toe points away from the workman, the sewing being commenced from the left-hand corner of the seat, the seat thus being sewn in first. The thread must be kept sufficiently supplied with wax, not only to neutralise the effects of friction caused by usage, but to keep each stitch from slipping out of place while the next is being formed. It does not follow, however, that a well waxed thread produces the strongest seam. The manner of pulling the stitches is of great importance, and unless proper pressure is applied, however well waxed the thread may be, the seam will be weak. Some of the best and most solid work we have seen has had comparatively little wax on the thread.

In ordinary work the number of stitches in a hand-sewn welt is from four to five to the inch. The pair of welts are prepared as follows:—Cut down the centre to reduce each welt to the necessary width, and level in a "plough" to the required substance. One edge is then levelled off with the knife. This is "feathering" the welt, and is done in order to facilitate the formation of a close, flat seam. The waist part of the welt is then reduced from the grain to half the substance of the welt to give lightness and additional pliancy to the waist. After the sewing in of the welt has been completed, it is hammered up square, and the edge pared with the aid of a piece of horn or zinc and the point of the knife. The hollow of the bottom is filled up solid and level with felt, a leather shank being fixed in the waist if required. The sole is now cut, and fitted as follows:—The forepart is made of a uniform substance and the waist reduced at the sides to half the substance of the forepart. This, again, as in the fitting of the welt, is for lightness and pliancy. The sole is then well hammered, pasted, and blocked into place with the hammer and sleeker. It is now pared to the welt, sufficient being left round the seat to beat over and cover the seat stitches after the heel is sewn on. The edges of the waist are now bevelled off with the knife. This bevelling is for the purpose of giving a light appearance to the edge, and to assist this end the bevelling of the waist edges renders it easier to beat

own the sole close to the upper with the pane of the hammer after the boot is stitched. A groove or channel is now cut all round the boot, from corner to corner of the heel, and opened. This is to sink the stitching on the sole side, so as to give a cleaner, lighter finish to the boot. In strong work, however, the channel is dispensed with, and the boot is stitched clean through, or "aloft," as it is termed. This is done mainly because of the stoutness of the thread required, to sink which would materially lessen the strength of the work.

The boot is now ready for stitching. This is performed with the boot held on the knee by the stirrup, so that the toe is towards the operator, the stitching, of course, being in the same direction. While stitching the waist, the thread is cast under, but in the forepart, where the stitch is shown, an overcast stitch is employed, because it gives a plumper and more prominent appearance to the stitching. The number of stitches is in proportion to the substance of the thread—the stouter the thread the less the number of stitches, from fifteen to twelve to the inch being the general rule for light medium and stout medium work respectively. After stitching the channel is pasted and rubbed down with an old file, the waist part beaten down to the upper, and the bottom generally "hammered out," wetted, and the grain scraped. The sole piece is now fixed (if it has not already been done at the time of preparing for stitching), and the sole prepared for the split-lifts by having a hollow pared out and rasped. In building the heel, two split-lifts and one whole lift are pegged in place and pared to shape, and then sewn on to the seat, the rest of the lifts required being fixed on two at a time with rivets. When the lifts have all been fixed, blinders are driven and sharpened, and on these the top-piece is hammered, and so fastened to the heel. Of course, the blinders are not placed where the outside nailing or sprigging will penetrate. After the top-piece has been fixed it is shaped and holed ready for sprigging, and it may be mentioned that the awl used for this purpose should be of the same character as the nails, otherwise they will not drive regularly. When sprigged, the top-piece is filed, the breast of the heel cut out, and the seat beaten down firm and solid over the seat stitches. Where the seat is to be cut, it is marked off level with the point of a stitching-awl held in the right hand, with the thumb and finger pressed against the top-piece as a guide. When the seat is cut out it is pared to the thick-

ness of the lip of the seat-wheel, and the "breaker" used to better prepare the seat for wheeling. When the edges have been prepared and rasped, the boots are ready for the operation of finishing, an operation fully described in a subsequent chapter.

The measure is freely used in making hand-sewn boots, and patterns are taken of the inner and outer soles and top-pieces. This is necessary, as the shape of the work in hand-made goods depends entirely upon the worker, and has to be fashioned as the work is proceeded with; whereas, in manufacturing, machinery greatly assists the operator in mechanically fashioning the various parts that have to be put together. As affecting time and cost this is one of the greatest differences between hand-made and machine-made work.

Very great alterations have been made in the past few years in welting machinery. The introduction of improved machinery for the performance of this operation has improved the character of the work. A lock-stitch welter has at last been produced, and doubtless presently there will be several machines for sewing in welts and making a lock-stitch. At present the only machines are the Ellis and Ramsden lock-stitch welter, and the International Goodyear.

It is doubtful, I think, whether there is any real advantage in the lock-stitch for a welter. On the welt side there is very much more strain required than on the insole side, and just what in the ordinary way is the defect of the chain-stitch becomes here, in my point of view, a virtue.

The principles of pump work are mainly used in the construction of the very lightest goods, and are as follows:—A single sole only is used, which is attached directly to the upper by means of a thread, forming a horizontal seam as distinct from a stitched vertical seam.

In sewrounds and pump work generally, the question of the substance of the sole in relation to the upper is one of much importance. It has already been explained that in pump-work no insole is used, consequently the weight and strain of the sole falls directly upon the upper, and according to the strength of the upper the substance of the sole must be gauged so as not to overtax that strength, else the seams will inevitably give way. Now, with regard to the sole itself. It is necessary that to give satisfaction in wear the sole shall be of the best sort. In order to insure this being so, many firms take stout soles, and have all that they consider superfluous

skived off, leaving only the very best of the sole—on the grain side—for the purpose required. This practice, however, is not usual, and, although a very conscientious one, is not to be recommended in the face of the fact that it is possible to get good light soles in every respect suitable for the class of work we are treating of. It is only to be reiterated, therefore, that given light, good soles, their substance should be regulated by the substance and strength of the material forming the upper; they should not be much stouter than the upper and side linings combined.

After the sole has been "fitted"—that is, wetted, the flesh side skived off, and hammered—it is cut to the desired shape, the shape being full to that of the last used, and then fixed on the last, grain downwards. The feather* is then prepared and holed ready for the thread, four or five stitches to the inch being sufficient for ordinary work.

Now, in pump work, it is necessary that the making shall be performed inside out, as it is only thus that the seaming can be done. That is why the sole is fixed grain downwards on the last. The uppers again have to be lasted inside out and upon opposite lasts—if right and left lasts are used. Thus, the right upper on the left last, and vice versa. In preparing the upper for lasting the side linings and stiffener should be pasted to the lining, but not to the upper. In lasting, small tacks are used, and they should only be driven half through the sole, and as few used as possible. If the upper is of woven fabric, the pull of the pincers must be straight, so that the material is evenly and straightly stretched. After the upper is lasted it is sewn in the usual manner. The last is next withdrawn and the pump turned with the aid of a long stick, the turning being commenced at the heel. When the turning has been accomplished the pump naturally presents a very crumpled appearance, to remedy which the fellow last is inserted in the shoe, so that the ill-treatment the shoe receives during the operation of turning may be put right in the second lasting, and the shoe is then finished. After the finishing the last is finally withdrawn and the pump completed by having a sock—and shank if required—well pasted to the sole.

If a heel is required, the heel part of the sole is left

* For explanation of "feathering" see description of hand-sewn process.

unsewn, and when the pump is turned, a half insole is fixed to the last before re-insertion, the half insole being, of course, properly prepared before fixing. When the last is replaced, the heel part of the upper is lasted, the seat sewn, the sole blocked over the seat, and the heel is then built in the customary manner.

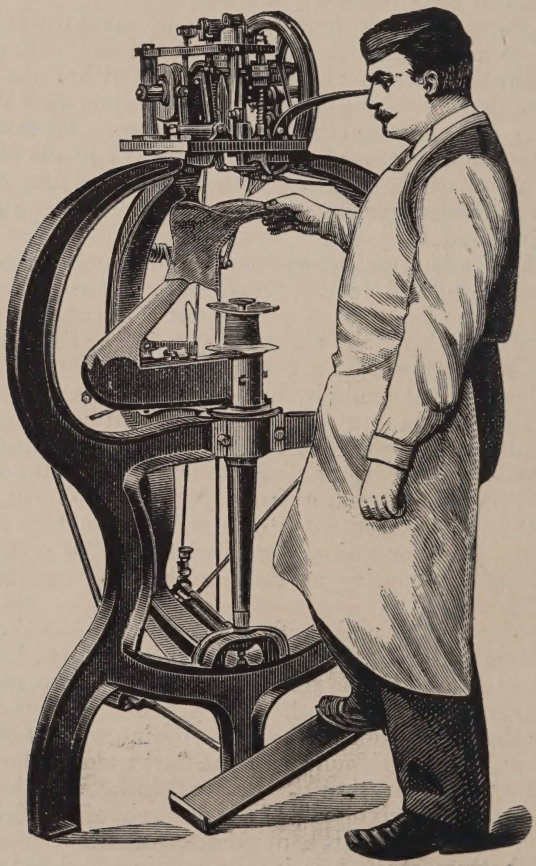
The process of making turn shoes by machine is very similar to that adopted in hand work, the difference being that the stitch forming the seam is either of a lock or chain character, the single thread chain-stitch being generally the more successful of the two. In lasting, about five tacks are used, with stout heavy heads of leather to allow of their easier withdrawal. When pump work is intended for dancing purposes, shanks should not be inserted.

A difficulty is sometimes experienced in making pump work for deformed feet. Thus, with a customer one only of whose feet has a prominent enlargement, the difficulty of making the right shoe on the left last is not hard to understand. To overcome this difficulty, the work is sometimes made by loop-stitching the sole to the upper; thus producing work quite as light as under the sewround process, without the necessity of turning the shoes inside out, or of making the left shoe on the right last. These goods are now known as "stitchdowns."

Riveted and pegged work by hand need not be dwelt upon after the foregoing descriptions. The processes are as easy to imagine as they are unnecessary to describe.

The enlargement and gradual development of the factory system in the boot trade of thirty years ago, by embracing within its boundaries makers and closers, as well as clickers and rough stuff men, rapidly prepared the way for the now extensive use of machinery in boot and shoe manufacture. Machinery was first used in the boot trade in the preparation of the stuff to be used by the "putters-up," or riveters. This branch of machinery has been brought to high perfection of late years, not only in bottom stuff, but in the cutting and machine rooms, many firms having their linings cut—dozens at a time—by a band saw; and skiving is principally done by machine, more mechanically, and consequently truer. But it was the introduction of the sewing machine that caused the greatest changes in all classes of boot work. The success of the sewing machine for uppers soon caused the application of its principle for the purpose of bottoming. The result was the Blake machine.

The "Blake" is a machine using a single thread, making a chain-stitch. The thread forms a "stitched vertical seam," going right through the sole, upper, and insole. The looping of the chain-stitch is worked into the channel made in the outsole, and a sock protects the



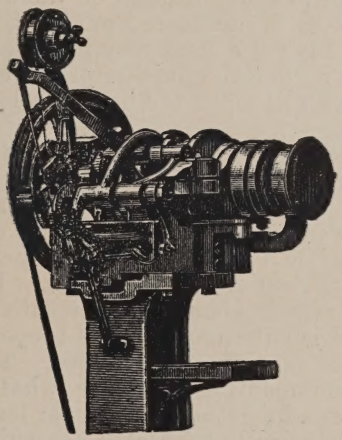
The Blake Machine.

foot from what thread is on the insole. In making, the upper is lasted as described in the commencement of this chapter. The workman stands at a bench, iron lasts being used, which are "slotted" on to an iron upright fixed into the bench.

After lasting, the bottom is filled up level, and the

sole (already shaped by machinery) is fixed temporarily with a few blinders and bedded to the last, a row of sprigs round the seat attaching that part to the insole. The channel is opened, the boot removed from the last and passed to the sole sewer, who has to take care that in sewing the boot is held to the machine so that the parts to be sewn shall not be displaced. The sewn boot is returned to the laster, who, replacing it on the last, proceeds to build up the heel, and roughly pare it, after which it is passed on to another department to be finished either by hand or machine.

In what is called fair-stitched work, a machine is used for producing an outside stitch in the same manner as



Welting Machine.

the stitch upon the welt in hand-made goods. The usual process is to sew a middle sole on to the forepart of a boot by means of the Blake machine. The outsole is next temporarily fixed, and the fair-stitching machine works round the forepart and stitches the middle sole to the outer sole. The waist is then sewn through in the usual way. This method of making produces a fine class of boot, and the extra strength gained by the additional row of stitching is most useful in stout work.

Fair-stitching machines are of two classes: Lock or chain-stitch. The lock-stitch machines are to be preferred to those making a chain stitch for many other reasons than for improved character of the stitch itself. A chain-stitch machine leaves the looped part in the channel, with the consequence that an abnormally deep channel has to be cut, and all sorts of dodges resorted

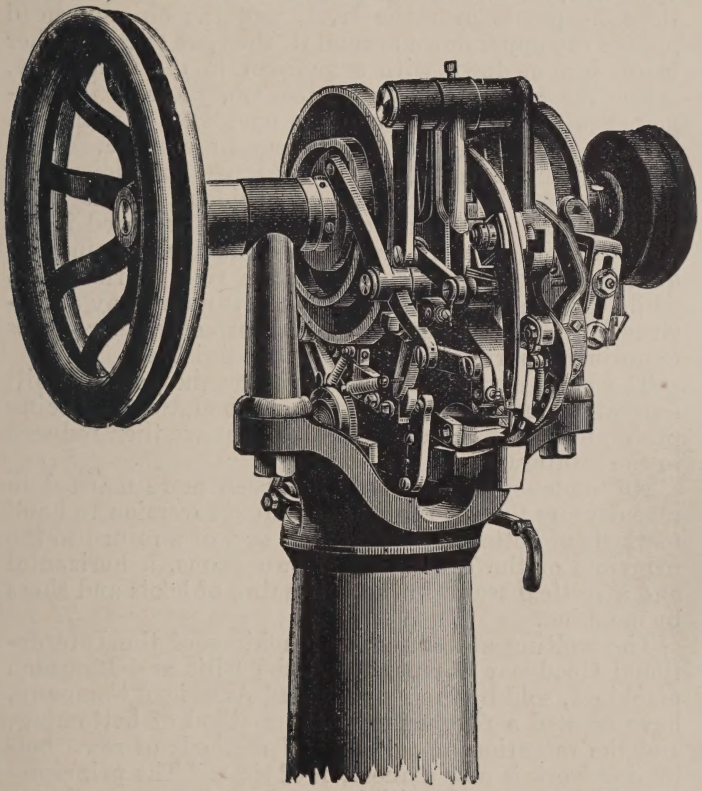
to in order to obtain a neat and secure closure of the channel. With lock-stitch machines a single thread is left in the channel, as with hand work, and a very superficial cut is sufficient to give a lip sufficient to effectually and securely cover the stitches. The work can be channelled very much closer to the edge, a tighter seam is made, and on some machines, such as the Ellis and Ramsden Lock-stitch Fair-stitcher, the work can hardly be detected from that done by hand. This is especially the case when a waxed thread is used.

Work made fair-stitched with a Blake clump should have the clumps sewn through as near to the feather as possible, and a very shallow groove made to take the stitch so as not to show through on the outer sole when the stitched boot is hammered out on the bottom. If the clump is Blaked a long way in, it will press away from the upper when the finisher pricks up the stitches, and altogether will make the boot of a loose and flabby character.

The Standard Screwer is an excellent machine, and is one of the most permanent advances ever made in machinery for boot manufacture. It is a machine which actually screws the work together—thus embodying the strongest possible means of uniting the bottom stuff. The screw itself, which may be of either brass or iron—usually of brass—is about one-sixteenth of an inch in diameter, and is cut from a coil of prepared screw-wire supplied to the machine from above. The machine is of a most accommodating character; whatever the thickness to be screwed together, the proper lengths of screw-wire are automatically regulated according to the substance of the parts to be united. Indeed, as the machine forms a vertical seam, the length cut off can be gauged so as to just keep clear of the grain of the insole, thus leaving it smooth and free to the foot. The standard screw method is much used in combination with other methods, especially with the fair-stitching machine, and is strongly to be recommended, inasmuch as it gives in the making a foundation the solidity of which is not to be surpassed, and one that will last out the leather of which the boot is composed. Two and three screws to the inch are all that is required for ordinary work.

To sum up the merits of the Standard Screwer, then: It is the best thing, viewed from the standpoint of solidity; but when the work produced is examined as to its flexibility, the merits of the machine in this respect are not so great. It is, therefore, most suitable for strong

work, and for the following reasons:—Stout work means extra weight, on account of the extra substance of leather necessary; the stouter the materials used, the less possibility there is of flexibility in the finished goods, no matter what system may have been employed in their manufacture. If solidity, therefore, is the chief desideratum, the Standard Screwer is the ideal machine for



Stitching Machine.

the manufacture of stout work of all classes. It may, with the Union fastening, also be termed a variation of riveting, but it is a variation that is certainly a most decided improvement upon ordinary riveting, inasmuch as it nails a boot in such a manner as to prevent all chances of the nails working up and injuring the foot.

In the Ab-Intra method the chief necessity is a special form of rivet with a barbed point. The mode of opera-

tion is as follows:—The insole of a boot is supplied with a row of these rivets; the heads of the rivets are on the grain side, and the barbed points stand up from the flesh side. The insole thus prepared is fixed to the last, and the upper is drawn over and forced over the points of the rivets. A special pair of pincers is used for this operation, having a circular head with a hole through it; the hole passes over the rivet, and the circular head presses the upper down around it, the edge of the feather being beaten down with a hammer in the usual way. After the bottom has been filled up, the sole is hammered on to the rivets, and the operation is complete. The row of rivets is continued around the insole, so that the seat is fixed as well. The neatness, simplicity, and cleanness of this method is self-evident. The more strain placed upon the work, the more prepared is the rivet to withstand it, and the permanent strain adequately prevents any chance of the rivet working up, while the head upon the inside is not in any way an obstruction, and the outsole, being perfectly clear, gives tempting opportunities for splendid finishes.

The heels may either be built upon the boot or built separately and afterwards attached, the latter way being preferable, as the chances for damages are then reduced to the minimum.

No tendency of the trade has been more marked in recent years than is the tendency to a reversion to hand methods of bottoming—that is to say, of a return to the principle of the utilisation of two seams, a horizontal and a vertical seam, in the bottoming of boots and shoes by machine.

The welting and stitching machines of the International Goodyear Company and the Ellis and Ramsden machines, sold by the English and American Company, have created a revolution in the method of bottoming, and the retention of entire hand methods of sewn bottoming work is now a question of time. The principles on which the work will be conducted are practically settled, and the final solution of all the difficulties we shall not have to wait many years for. The method is not perfect. The channelling of the insoles will have to be rendered much more simple, and shallower channellings will have to be obtained before the work will be really reliable at this point. Narrow toed machine welted work is likely to be weak at the toes, on account of the distance separating the two channels, and the consequent disparity between the radii of the outer and

inner parts of the seams. Thus either the stitches must be long on the welt at this point and loosely pulled in, or the points on the inner channel, where the needle strikes, must be so close together as to deteriorate the inner sole at that point, and in either case the result is not a tight seam. The engineers who have designed the machines are, we believe, fully acquainted with the weakness of this point, and are hopeful of soon obviating the thing complained of.

The inner soles for machine-welted work are generally worked perfectly dry in the usual manner, with lasting tacks if the work is put up by hand, and the next process is to brace the work and withdraw the tacks preliminary to handing to the operator. This bracing, when performed by hand, is done by passing a long thread round the toe through the lip of the outer channel, and then through two or three times along the length of the boot. The upper is then caused to lie close to the turned-up lip of this outer channel, and flat upon the feather of the inner sole. The work so prepared is handed to the operator, and the welt is sewn in. Leaving the machine, the welt has to be pared down and beaten up. In order that the stitching may be effectually done the welt must be beaten out perfectly flat and level, and this is usually accomplished by a small power hammer running at a very high speed, called a "Welt Beater."

The welt pared and beaten up, the bottom has to be filled and the sole fitted, channelled, and attached by means of the stitcher.

The heel is then built, either by sewing in the seats by hand or by riveting the seat in when the lasts are plated at the seats. The work is then ready for the finisher, who should preferably be a man having an experience of hand-made work.

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## QUESTIONS FOR CHAPTER XII.

1.—State how you would proceed to last a boot to be made under the hand-stitched process.

2.—What is "horsing"?

3.—What is to be understood by a "horizontal" and what by a "vertical" seam?

4.—In a machine welter is there any special need that the machine should be of the "two-thread" variety?

5.—Enumerate the orders into which lasting machines naturally fall.

## CHAPTER XIII.

### Finishing, and the Kit Employed.

Authorities:—Beyond the essays contributed to the early numbers of the "Shoe and Leather Record," mainly by Mr. Swaysland, there is no literature on this subject.

FINISHING is the process by which boots are finally prepared for shop after the bottom stuff has been attached to the uppers. There are many ways in which boots may be finished, much depending upon the neighbourhood, and more upon the character of the work to be finished; men's work being finished after a sober fashion, while it is in women's work principally that all the efforts at embellishment find free play—in "fiddle" waists, coloured top-pieces, etc. Startling and novel indeed has been the effect of the efforts of some firms to produce especial kinds of finishing, and it has even been proved possible to register any particular kind of finish that is entirely new. These effects, however, are mainly the result of individual effort for the purposes of advertisement, and with them the ordinary finisher has nothing whatever to do. But there are certain stereotyped, distinguished methods of finishing boots which are usual with all firms, and as the main object of finishing is, after all, not that a boot should be finished in any unusual manner, but that it should be finished well, it is the ordinary methods of finishing that will be treated of in this chapter; and as all the variations of ordinary finishing are more or less connected with the usual methods employed in bespoke finishing, it has been deemed best to give first an example of finishing ordinary bespoke work, as that forms the basis of all other processes of finishing.

It is assumed that the boots are in rasp and of ordinary calf, and that they are to be finished black and white. The edges of the heel and forepart are damped with a wet brush. This has the effect of setting the fibres of the leather in such a manner that when the next operation

—that of scraping—is performed, the edges are of an even and smooth nature. If the damping was neglected the edge would scrape up rough, and the finish ultimately would not be so hard, brilliant, or enduring. In the operation of scraping, the buff-knife must not be held slanting, but the pressure should be even, or the surface scraped will have a "ribbed" appearance. After the edges are scraped, it is best to deal with the forepart separately. The loose fluff on the top of the welt, which has been worked up by the scraping of the edge, is cleared away with the welt-knife and the stitches rubbed down with a bone, notched lightly at one end in a slanting manner. This rubbing down levels the welt and clears the superfluous wax away from the thread, and at the same time prepares the stitches for the after-operation of pricking. To facilitate the rubbing-down of the stitches, a little gum and tallow should be rubbed on the welt by means of a rag wrapped round the thumb of the right hand in such a manner that it is the thumb-nail which performs the rubbing on the welt of the grease and gum. The thumb-nail is useful in other ways besides this, such as cleaning out the breast of the heel, or behind the seat; indeed, it is one of the most useful pieces of kit (if the term may be allowed) belonging to the bootmaker or finisher—its usefulness lying in its readiness and adaptability. A stitching awl, guided by the thumb round the top-piece, is now used to scratch or mark a line round the seat of the heel, as a guide to the knife in paring the seat level. When the seat is pared level and is rasped and filed to the proper thickness, a tool—termed a breaker—is used to further perfect the levelness and prepare it so that the seat wheel shall run easier. The edges of the waist are now prepared for the waist-iron. This is done as follows:—The loose welt is cut out so that it shall range with the forepart and seat; the edge is pared, scraped, and fitted to the size of the waist-iron that is to be used. When this is so, the edges are damped and the waist-iron is run cold. This sets the shape of the edge to that of the iron. In running the waist-iron, care should be taken that the pressure is of such a character as to press the edge of the waist close and firm to the upper, and not to bulge the sole away from it.

The top-piece and the sprigs or nails in it are now fine filed, and the boot is ready for sandpapering. When this has been done, the forepart iron is tried, and, if necessary, the edge is reduced by filing it to fit, at the same

time forcing up the crease by an outward motion of the file. The iron should fit easily, but not tight. If it fits too tightly, it will not only be hard to use, but the after-guard of the iron will press on the face of the welt, and cause the stitching to look unsightly. If it fits too loosely, the iron will be unsteady in the handling, and cause the edges to be of a "barrelly" appearance. This having been seen to, the boot is ready to "damp" down. This damping down is accomplished with a wet rag, all those parts intended to be inked being subjected to the process. Many finishers use a little paste on the rag to obtain a still smoother surface. The boot is now ready for colour, but before being inked it is usual to first run the seat-wheel, waist, and forepart irons, the kit, of course, being warm. The reason for this is that the finish should be harder. The stitches are now divided with a prick-stitch, an implement generally made from the stump of an old knife.

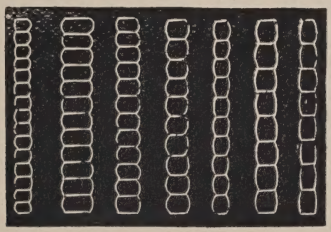
The boot is now inked. It should not be allowed to get too dry, as if it does it will not only be harder to finish, but the finish will not be so good. Indeed, the quicker a boot is finished after it is inked, the more easily will the process be accomplished, and, generally speaking, the better will be the finish, because the boot is in a mellow condition, leather being always more workable when in a mellow state. As soon as the boot is dry, any sediment is removed with a brush or rag, and the top-piece and waist sleeked with a bone. While this is being done, the glazer should be heating; and, when hot enough, the heel, top-piece, and waist should be burnished. The glazer is a heavy, somewhat triangular-shaped piece of iron, with a smooth, half-round face, about one inch broad. This is set in a large wooden handle, and it is, altogether, a tool by which the large amount of power required in order to polish a considerable surface of the boot is effectively applied. The effect of the burnishing is to harden the surface of the leather to a considerable degree. This is caused by the heat of the tool used. It is on account of the application of heat, combined with the heel ball or polish used, that the polish is so lasting in its brilliancy. When the glazer has been once used, heel ball is applied, and the glazer having been re-heated is used again to iron the heel-ball into the pores. When the glazing is completed, the seat wheel is run a second and final time.

The waist is now ironed, heel ball being used here, as also in the forepart, which, after the stitches have been

pricked a second time, is next ironed. In order to give a more finished appearance to the edge of the welt, and to improve the look of the stitch, the forepart iron is run a second time, and the jigger mark set on the welt, which has the foregoing effect.

The boot is now described as "ironed up," and the heel ball is briskly rubbed off with a cloth, care being taken to rub so that the polish shall be improved; to this end, after the ironed heel ball is removed, a little fresh heel ball is rubbed on to the cloth, which is lightly passed over those portions of the boot from which the superfluous "dead" heel ball has been removed.

The bottom is next prepared as follows.—It is scraped clean with the buff-knife and then well sandpapered. A little bottom ball (either buff, yellow, or pink colour



Fudge-wheel Patterns.

generally, and preferably buff) is scraped on to the surface of the bottom and sandpapered into the grain of the leather. The surface is now damped down with a flannel. This damping down may be accomplished either with a flannel that has been dipped in water and squeezed to get rid of the superfluous moisture or by the aid of a little saliva. If a number of bottoms have to be damped at one time, the first way is preferable, but if only one or two pairs have to be done, the latter way is used as being more "ready." The bottom is then rubbed with a dry rag; or, if a more polished appearance is desired, a little French chalk is sprinkled over the surface, lightly patted all over, and then dusted off. The "jim-crow" is now run on the waist channels, and the top of the waist marked with a dull knife; a little beeswax is rubbed on the forepart channel, and the forepart iron is warmed and passed round the edge to melt the wax and give the channel an even brown colour. The residue of the wax is now cleared off with a knife, and

the edge rubbed up with a cloth; the last is withdrawn, the pegs cut out, and the insole scraped.

The feather is next "poked" out over the face of the welt in an even manner, then rubbed down with the point of the long-stick to set it close; the boot being put into shape as much as possible, and to appear as though the last was inside. The upper, if calf, is damped and smoothed with a rag. The boot is now polished with white wax, and the operation of finishing is complete.

Sometimes the boots are finished all black. This way is very useful for shop work, as it can be so easily re-finished, and the boot does not show the effect of "handling" much, if to any degree. The method is also very appropriate for strong, stout work, as the effect of a black bottom, well finished, tends to give the boot a good, solid appearance.

"Fiddle waists"—as they are called, no doubt, from a fancied resemblance in shape and colour to the back of a violin—are made by carefully scraping and sandpapering the waist, smoothing the grain by help of a little clean, thin paste and moisture from a wet rag, allowing it to dry, and then sleeking with a bone, and afterwards polishing with a rag upon which has been smeared white wax. According to the length of time, the waist is allowed to dry, so the depth of colour is influenced; the shorter the time allowed after the first dampness has evaporated, the deeper will the colour be; and the colour, of course, will be lighter the longer the waist is allowed to dry. It is best, however, to get a medium colour, as the darker ones are harder to manage, and the very light ones are apt to prove too delicate. It is now usual in machine-made work to make "fiddles" with the colour derived from one of the aniline dyes mixed with gum. Glycidine will be found to give a nice colour. It will be seen from this that it is important to gauge the time allowed for drying, in order to get both waists the same colour, cleanliness at the same time being the chief requisite if a good waist is to be the result.

Coloured top-pieces are made as follows:—After the top-piece has been filed and sandpapered it is damped down with a little paste. Some dry oxalic acid is next placed in the centre of the top-piece. The face of a good sized cork bung is dipped in water and rubbed over the face of the top-piece, crushing the oxalic acid, the amount of which should not be more than can be pinched between the thumb and the fore and middle fingers. The

effect is this: The moisture from the bung dissolves the oxalic, which, being spread by the rubbing, cleans all the dirt away from the top-piece, leaving it a clear, even, neutral colour. A rag is now doubled over the forefinger and a little ink applied to the rag. The rag is now rubbed over the top-piece, the oxalic unites with some property of the ink, and the result is that nice red tinge so well known in this kind of finish, the depth of the colour depending upon the amount of ink used.

Polished brown bottoms, so much favoured for strong work and work stitched "aloft," are made as follows:—The bottom is scraped and sandpapered, coloured with a little brown ochre, damped down, allowed to dry, and then sleeked, and afterwards polished with beeswax. For strong work—in bottoms of this sort it looks better to brown the waist and top-piece as well as the forepart, the result being a fine, hard appearance, more in accordance with the natural colour of the grain. Sometimes a little red ochre is used as a change, though it tends to make the appearance of the bottom too gaudy.

Such are the ordinary methods employed in bespoke finishing, and it will be seen that the operations are most thorough, and involve a large amount of labour and care.

In manufacturing finishing, it is sought to produce the desired results in as expeditious a manner as possible. Everything is done that will possibly aid and shorten each and every operation, such as using quick-drying and quick-burnishing inks, and the introduction of "fake" to take the place of heel ball. This ambition—if it can be called such—has been the cause of many variations, and in some cases improvements, in the processes of finishing. The heel-shave, for quickening the operation of smoothing the edge of the heel by obviating the use of the knife and rasp, which are comparatively slow, is especially useful where a curve is desired on the heel. The welt-trimmer, for ploughing and levelling the face of the welt and getting that even surface which is most favourable for the production of a plump imitation stitch by means of the fudge-wheel (another innovation), and the edge-plane, for rendering unnecessary the use of the knife and rasp on the forepart are all, when properly used, admirable and useful.

"Fake" is the name given to a pasty compound that is used as follows:—When the inked parts of a boot are burnished with the glazer the first time, the fake is

rubbed on with the finger and allowed to set awhile. The use of fake, of course, obviates the ironing in of heel ball, and thus saves something like 50 per cent. of the labour of burnishing.

The result of using this compound, combined with the use of good ink, gives a passable polish, but the finish is not so durable as the older but more troublesome and longer method of glazing heel ball into the pores of the leather. The substances that enter into the composition of fake are black heel balls, polishing balls of white wax, and beeswax.

According to the proportions in which these are used, so the fake is either hard or soft, brilliant or deep. The more white wax, the harder and more brilliant the polish obtained. The more beeswax, the softer will be the fake; and the more heel ball used, the deeper the finish. These substances are dissolved in spirits, either naphtha, turpentine, or benzine, the exact manner of preparing fake being as follows:—Take the parts of heel ball and wax it is intended to use and cut or crush into small pieces and place them in a shallow tin box. Place the box over a spirit-lamp in order to melt the substances, stirring at the same time with a piece of wire. When melted, remove the box from the lamp to prevent accident, and quickly pour in the spirit it is intended to use, afterwards stirring together and thoroughly mixing. According to the quantity of spirits used, so will the fake be hard or soft. To produce a fake that is easy to use, equal parts, by measure, of spirits and of the solids should be used. If through evaporation the fake gets hard, re-melt, and add more spirits. The mixing of the spirits with the melted substances should be performed as quickly as possible. Below are recipes for a few of the most commonly used polishes:—

For a brilliant, hard polish.—Two parts of heel ball, three parts of white wax, same quantity of benzine or naphtha. Add two parts of beeswax if it is intended to be softer.

For a deep, black, easy polish.—Four parts of heel ball, one part of beeswax, same quantity of turpentine. If wanted harder, use white wax instead of beeswax.

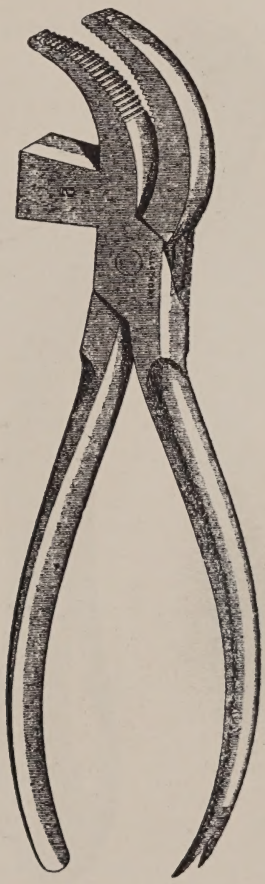
Equal parts of white wax and beeswax mixed with turpentine produce an excellent fake for polishing fiddle waists and brown bottoms, and for the final polishing of ordinary work.

The team system, even in the comparatively short process of manufacturing finishing, is becoming an ac-

complished fact. The extensive introduction of machinery capable of performing various parts of the process of finishing accounts for this to a great extent. From a workman's point of view, the team system, no matter

Heel Shave.

Sole Plane.

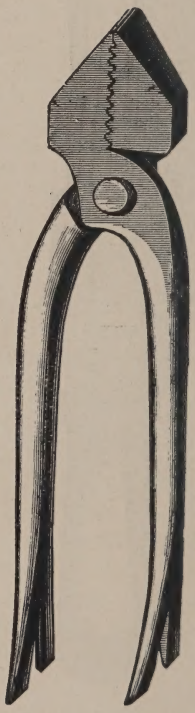


Lasting Pincers.

what part of industry it has affected, has always been injurious to him, in so much as it decidedly tends to such a splitting up of operations as to reduce each part to the nature of a mere mechanical effort, in the performance of which no particular skill is required, and so cheapen-

ing the scale of wages by the introduction of boy and female labour. Its application to finishing has come with the introduction of various finishing machines, and

Waist Pincers.



French Pincers.

when, in process of time, these machines are perfected, finishing by the team system, with the aid of machinery, will be done as well as, if not better than, by hand.

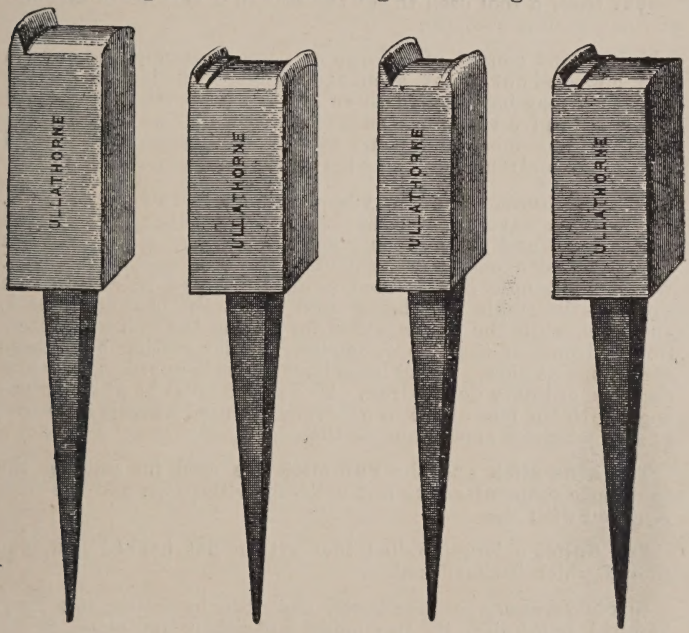
The following tools are employed in finishing bespoke work:—

**Knives** may be either English or French. French paring knives are long pieces of steel, without a handle, sharpened obliquely at one end.

**Rasps and Files,** to follow the use of the knife, may be either single or combined.

**Scraper or Buff-knife,** to remove the rasp and file marks, preparatory to the use of sandpaper.

**Welt Plough.**—A tool like a chisel, bent on the flat, having the addition of a guard at the end as a guide in usage.




Single and Double Forepart Irons.

**Seat File.**—A curved tool, with one side prepared like a file, used in preparing the back of the seat and waist. It has generally the end pointed and hooked, to serve as a channel opener.

**Glazer.**—Already described as a heavy, somewhat triangular-shaped piece of iron, with a smooth half-round face about one inch broad. This piece of iron is set in a large wooden handle. The face of the glazer, or burnishing iron, as it is often called, has sometimes a rebate cut out at the end, the rebate being cut in such a manner that its inside edge forms a top-piece wire.

**Breaker.**—A tool with a guard like an ordinary forepart iron, and the face cut like a plain file. This is used to prepare the seat for the use of the—

**Seat Wheel,** which consists of a rectangular-shaped piece of iron, technically called a forge, one end being fixed in a handle of wood, and the other end forming the face of the iron, having a back-guard at one side, cut at rather more than a right angle to the face of the iron, a small part of the face being left in front of the guard as a quarter-crease, immediately beyond which is a slot for holding a wheel or roller. The tool is finally used to set the seat close to the upper, and by means of the back-guard quarter-crease and roller to give a better finish to the appearance of the heel than is accomplished by the—

**Seat Iron,** a tool used to set the seat in a very plain fashion, and now almost obsolete.

**Waist Irons** consist of a forge or body, a back-guard, and a face, hollowed out or flat, at an acute angle with the guard. The waist iron may be either plain or with a wire between the guard and face to give the appearance of a jigger mark. Round waist irons are now most in favour, as they take more leather, and thus tend to strengthen the edge of the waist.

**Forepart Irons.**—These may be either single or double or bevel. Single irons have to a great extent been superseded by the double iron, and are now only used for strong, stout work, as being more convenient on account of the stoutness of the edge. Where the single iron is used a jigger is used in conjunction with it—the single iron being used to set the channel, crease, and edge, while the jigger is used for setting the welt and stitch. Double irons, as their name implies, are for setting both these operations at once. Bevel irons have the sole guard made wider than the ordinary double iron. This guard must be at an obtuse angle with the face of the iron. They are used when it is desired to give a lighter appearance to the edge.

The **Long-stick** and the **Puff-stick** are used for putting the boots into shape after the last has been withdrawn and the pegs removed with the—

**Peg Knife,** a long-handled tool with a flat hooked end, one side of which is sharpened.

**Insole Scraper,** perhaps better described by calling it a long-handled buff-knife, its use being sufficiently indicated by its name.

In bespoke work, where the bottoming is done by one pair of hands, the ordinary difficulties of finishing are guarded against by the carefulness with which the operations preceding that of finishing are performed, for it is from these preceding operations that many of the difficulties arise, more especially those arising from discoloured bottoms. It is in manufacturing finishing, therefore, that difficulties are more often encountered, simply because in the other parts of the work the finisher is not studied as he deserves to be. It is in this respect that technical education becomes of special value, for, if the workman in one part had a knowledge of the

technique of the process that followed his part, he would be more likely to do his own work in such a manner as would not tend to hamper, and perhaps spoil, the efforts of the workman next in order to himself. Take an instance: The cause of an unlevel seat, more often than not, could be easily traced to the carelessness in which the laster has bedded the stiffener and prepared the foundation of the heel. Many difficulties, not only of finishing, but of manufacturing generally, could be overcome if only the workmen were possessed of an acquaintance with outside processes; if the workman, instead of being kept, through no fault of his own, to one portion of the trade, was enabled to acquire a knowledge of the technology of the trade in the most practical and broadest sense of the term.

One of the most annoying difficulties in finishing is a discoloured sole; and it is scarcely possible to get a good result in the attempt to hide the stains, and at the same time to finish the work in the usual manner. It arises from more than one cause, but the chief is that the leather is not properly wetted and prepared by the rough-stuff man. Leather is placed in water to render it easier to work, and to do this must be thoroughly wetted, or the bottom will become discoloured when finished. Stains used at one time to be frequent from the rolling of the leather while in too wet a state, owing to the influence of the iron rollers. Galvanised and gun-metal rollers are now, however, in general use, and their introduction has altogether prevented stains arising from this cause. In machine-sewn work, stains frequently arise from the use of wax containing too great a proportion of pitch, from badly made wax, and from the overboiling of it by the machine. More attention to these matters would minimise the evil almost altogether. When wax is too pitchy, badly made, or overboiled, it loses its properties, leaves the thread more readily, and is more easily absorbed by the leather. Boots exposed in the window during hot weather will also show stains from this cause, so that the finisher has very often to hide stains and improve the appearance of boots after they have been in stock for some time. In dealing with these difficulties, if it is intended to try and keep the bottom white, and the discolourations are the results of the leather not being properly prepared and wetted, the finisher, after scraping, should dry the bottoms in front of a fire, and while warm the sandpaper should be briskly

used. Then scrape plenty of bottom ball on the discoloured parts, and sandpaper that well into the grain, damp down lightly but evenly, and puff a little powdered bottom ball on after the damping down. If the discolourations are considered to be too much for this process to overcome, the bottom had better be prepared as a polished one with brown ochre. If the stains arise from the overloading of the thread with wax, or the use of inferior wax, they cannot be permanently hidden in damp-down work. Though hidden for a time, the stains will eventually show on the grain, because the leather will continue to absorb the wax from the thread while there is any left. Boots showing stains of this character should be completely re-finished all black as the only satisfactory way of permanently dealing with them.

Sometimes after a boot is inked and sleeked, it will show up grey and spotty. Sometimes this is in consequence of not allowing the ink to dry sufficiently; sometimes in allowing it to dry too much. In the first case, the grey parts should be re-inked and allowed to get dry enough. In the second, it will generally be found sufficient to damp with a linen rag moistened with a little ink, and re-sleek the parts. If in inking it is found that the ink does not "strike" well, through the leather being hard-grained and horny, rubbing the ink in with a piece of stone or slate will be of assistance; or, if this be insufficient, then apply ammonia to the part, when the ink will strike readily. In glazing the edge of the heel, if the face of the glazer is lightly passed over a piece of fine emery cloth, a more solid polish will be the result. If the channel is sleeked with a bone before scraping the bottom, there will be less chance of the scraper wrinkling or ribbing the lap of the channel.

American burnishing ink is now universally used in finishing. It is dirty and objectionable—at least, the ordinary kind—but it strikes well, and when properly managed gives an easy and brilliant polish with less expenditure of manual labour. It is likely to get "cakey" and thick. When it gets in this state, it can be easily improved by the addition of a little methylated spirits. It is also much improved if English ink is added to it, together with a piece of gum arabic. In damping down the uppers of calf work, gum dragon will be found very useful in giving a fine, smooth appearance. In patent and enamelled work, paraffin or a little rectified ether will readily clean off any dirt, wax, or spots.

It will be seen that in bespoke finishing, through the lesser quantity done, and because it has to be done by a workman who has the entire bottoming depending upon him, the labour and process of finishing is heavier and more laborious, whilst in manufacturing finishing, the operator, doing nothing else but finishing, acquires by constant practice such skill as enables him to materially lessen the labour and quicken the process, without depreciating the quality to any marked extent. This is one reason why manufacturing finishing is so rapid.

The subject of this chapter has been exhaustively gone into in the hope that it will be of such assistance to the average student as to enable him, not only to thoroughly grasp the principles of finishing, but, if he has the inclination (which it is hoped he has), to experiment a little on his own account.

At the same time, it is hoped that the explanations here given will prove of some assistance to finishers proper, for it cannot be denied that there is a class of finishers who stand in need of information, though, as a whole, manufacturing finishing is now performed in a far more praiseworthy manner than formerly.

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## QUESTIONS FOR CHAPTER XIII.

1.—Describe how a hand-sewn boot is finished.

2.—What is to be understood by (a) French bottom, (b) DD bottom, (c) fiddle waist?

3.—How may "fake" be made?

4.—How may a brown bottom be obtained?

5.—What is an "oxalic top-piece"?

## CHAPTER XIV.

### Hygiene: Its Relation to Footgear.

Authorities:—For the purely scientific aspect the text-book by Dr. Willoughby will be found useful; there is much that is suggestive and helpful in Dr. Jaeger's "Health Culture"; the authorities under Chapter I. also bear upon this.

Thomas Carlyle, in a characteristic letter, said that, whilst we "have a public suffering much in its feet, but few shoemakers possess the actual art of making shoes which are easy to the wearer." Without endorsing the whole of "The Sage's" statement with approval, it may be safely said that Carlyle has expressed a general truth it would be hard to contradict. Yet that such a statement should be true even now does not augur well for the principles on which our methods of manufacture are founded, and herein is an ample justification for the aims and methods of technical educationists. It is not that the mere manipulation of the leather into boots and shoes has not been well performed, but that in the past boot manufacturers have been wanting in a knowledge of the mechanical and physical functions of the foot. The science which treats of the preservation of these functions in health is known as hygiene; and, in order to properly construct boots and shoes which shall meet every demand of the foot for healthy action, it is necessary to have a knowledge of this science; at any rate, so far as it has relation to the functions of the foot.

Man is distinguished in the whole creation by his erect posture; for, although other creatures sometimes assume that attitude for a period, such as the bear in fighting, and the ape occasionally in running, yet to man alone is the position natural and constant. Now, this position is not maintained merely by virtue of the width of the base—the feet—on which the man stands, but by virtue of the power exerted in antagonistic direc-

tions by the muscles of the body. These muscles, pulling in opposite directions, balance the body, so that man is enabled to naturally maintain his dignified and distinguishing posture. The muscles connected with the foot play a most important part in this function, which Paley has very happily termed the "faculty of standing." Accordingly, it is of the very first importance that the muscles of the foot should have an unrestrained action, and this can only be accomplished by the right formation of the footgear.

It is not necessary here to detail the mechanical principles upon which walking is conducted, such principles having been dealt with in detail in the first chapter, to which the student's attention is again directed. In that chapter the primary actions of the foot, such as the raising of the heel, standing upon the toes, etc., were explained and illustrated. But there are other and more complex actions, both mechanical and physical, which must be regarded in the construction of footgear intended to be truly hygienic. Thus, if the sole of the foot be examined, it will be observed that it is not by any means flat but that it has certain well-marked elevations and depressions.* It has two well-defined arches—the longitudinal at the waist, and the transverse between the outside and inside of the tripod bearings. These two arches bear a most important relation to the footgear, and it is of their actions that we shall now treat. It was shown in Chapter I. that the gliding joint of the tarsals of the foot formed one of its most important functions. In fact, that from the movement of the astragalus over the calcaneum it is necessary to have the boot longer than the foot, to allow of this elongation of the foot under pressure. Now, the amount of the length of the boot beyond the length of the foot is determined, first, by the degree of this longitudinal arch; secondly, by the substance of the footgear; and, thirdly, by the height of the heel. The higher the arch, the less will be the degree of the foot's elongation. The softer the material and the higher the heel, the less will be the length of the boot or shoe beyond the length of the foot required. The lower the heel and the stouter the material, the greater will be the additional length required.

Fig. 1 shows the foot as viewed from the inside, and displays a well-defined arch, of which the piers are the

* The shape of the sole—that is, the outline shape best suited for healthy feet—is discussed in Chapter IV.

calcaneum and the first metatarsal; the outside arch itself consisting of the astragalus, the scaphoid, and the cuboid bones. When pressure devolves upon this longitudinal arch, its tendency is to flatten and lie in a straight line; and, according to the degree of the arch, so may this straight line be longer or shorter.

Fig. I.—The Foot viewed from the Inside.*

Many children, as we can vouch, are being crippled for life by the wearing of so-called hygienic footgear, which is hygienic only in name, and which fails to properly regard this fundamental principle, namely, that the boot must be to such an extent longer than the foot as to allow of its natural elongation. But who can wonder at the ignorance of the majority when such statements as have been made by Mr. Dowie in his work on "The Foot and Its Covering" have received the sanction and support of a learned society and of medical men? We are told by the author referred to "that the sole must have elastic material that will elongate and bend easily at the waist,"† in order to allow of the natural lengthening of the foot. Granted the foot lengthens from the waist, cannot this difference in the

Fig. II.—The Foot viewed from the Outside.

length be provided for in a manner less evil and simpler than by making the foot act the part of a lengthening stretcher? According to the theory under discussion, it is not hard to see wherein so many of the so-called hygienic boots so lamentably fail. With the proper

* From photographs by Mr. H. W. Morris.

† "The Foot and Its Covering," pp. 120-1; see also p. 70, par. 223-4.

amount of length, the boots are usually too wide at the ankle and heel, and are accordingly sold by the retailer too short, in order to secure a respectable fit at the ankle and leg. It is of as much importance to the unrestrained lengthening of the foot that the boot should fit closely at the ankle as it is that there should be a proper regulation of the length. If the boot by measurement is long enough, if too large at the ankle and heel it will be all too short; for the boot, being baggy at the ankle, allows the foot to slip forward, leaving a space at the back of the heel, and rendering the wear in all respects as injurious to the foot as a short boot. Wholesale manufacturers of these goods, too, often forget that, by widening the forepart of the boot, they allow of a free action of the foot, and that it is unnecessary to widen the leg of the boot because of the extra width of the forepart.

Seeing, then, that the greatest action of the foot is from the waist, it will be well here to consider the requirements of the foot for a healthy action at this part. Mr. Dowie constructs, or did construct, his boots with indiarubber waists, in order to lengthen with the foot. But this practice is, undoubtedly, formed on an erroneous assumption. The waist, without doubt, should be pliable, for the simple purpose of allowing free play to the foot at a most important part, but that it should be of such a nature as to admit of contraction and expansion is a doctrine against which we must strongly protest.

Although the greatest flexion of the foot does not take place at the waist, but at the articulation of the phalanges with the metatarsals, still, as it will be our endeavour to show, the greatest bending power of the footgear must be, from various causes, at the waist, and not particularly so at the forepart.

In the most important action of walking, the foot is acted upon as a lever of the second order (F.W.P.). Thus, in taking a step, the toes rest upon the ground as the fulcrum, the weight is the resistance transmitted by the body through the bones of the leg to the arch of the foot; the power is exerted by the contraction of the muscle of the calf. Now, although the bending action in such a lever is from the point of the fulcrum, such point is necessarily a fixed one, and, therefore, practically, the flexion is not from that point, but from a point immediately behind it. Thus, then, it must be the endeavour of the boot manufacturer to fix the point

of greatest flexion in a boot as immediate to the joints of the phalanges with the metatarsals as is possible.

An observance of the diagram of the bones of the foot (given below) will show that these joints do not lie in a horizontal line, but obliquely. Therefore, this line of greatest flexion in the boot must lie in an oblique direction as well.

To secure the greatest flexion immediately behind the fulcrum of the foot in the action of walking, it is necessary to have the inside waist so shaped as to be larger than the outside waist. And, further, it is necessary to have the waist of such a length that it shall reach imme-

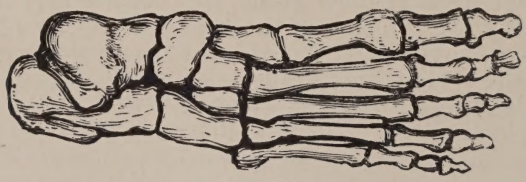

Fig. III.

diately to the back of the fulcrum point. This latter is accomplished by forming the sole shape according to the third method explained in Chapter IV.*

Thus we see that it is at the waist of the boot that the greatest flexion must be possible. Of course, it is advisable to render the whole of the sole of the boot as perfectly pliable as the waist, but as this endeavour would militate against the other objects of the boot, such as the resistance to dampness, wear, etc., it is only found advisable to render the waist part thin in order to obtain the requisite pliability. Yet the waist is needed pliable only at certain parts. We have shown that one part must be just immediately behind the fulcrum point. This is allowed for by the shape of the sole. But, as is

* This method, which is an improved form of Mr. Hannibal's, is founded on the assumption that, in healthy feet, the heel is one-fourth, and that the toes are one-third, of the whole length. As these proportions may be called in question, it will be as well here to give the authority on which the statements are made. Albert Durer, in his work on "The Proportions of the Human Figure," page 55, gives these proportions. On page 22 he gives two-sevenths as the correct proportion, and in that, therefore, contradicts himself; yet that a third is the proportion usually adopted as correct may be proved by the measurement of the masterpieces of statuary. In Jean de Witt's copy of the Venus de Medicis, the toes are exactly one-third.

well known, the shank and the manner of its disposal play a most important part in deciding the character of the waist. The purpose of the shank should be to afford extra support to those parts of the waist which specially need it. For instance, the calcaneum, as far as the waist of the boot is concerned, is a fixture. If this is not properly supported from underneath (when boots or shoes with heels are worn) it will be speedily depressed at one end, and be a cause of flat foot, especially with children.*

It must be the object of the shank to support this part of the foot, but only this part. An observation of the bones, as illustrated in the diagrams given in this chapter, shows that the calcaneum extends to a position indicated by a point midway in a waist of the nature and length we have referred to. Further, let it be observed that the calcaneum is longer on the outside than on the inside. Accordingly, the shank must not proceed further than the middle of the length of the waist, and must be placed more to the outer than to the inner side. This is in direct contradiction to the received opinion, but we, nevertheless, maintain that it is a method warranted by a study of the anatomy of the foot, and that it is supported by practical experience. In the whole method of making Wellingtons it was usual to build up the waist with three or four thicknesses of sole leather, in order to secure rigidity of the waist, so that, for one reason, the boot might keep its shape during the withdrawal of the last. Most foreign boots are, at present, made with very stiff waists, the principle being carried so far in this class of goods as to give stiff, unyielding waists even to dancing shoes.

Some makers, notably Mr. Cremer, of Bond-street, and Mr. Burgess, substitute a steel spring for the leather shank in the waist of the boot. In many respects the steel spring, as used by first-class manufacturers, is an improvement, but this is more than can be said for the usual method of placing a stiff piece of steel in the waist, and firmly securing it at both ends. The steel in such a case is not a "spring" in any sense of the word. To act properly, one end, at least, must be free to play in a proper slide provided for the purpose at the extremity nearest the toe. But it is somewhat doubtful whether the system of providing artificial springs for healthy feet

* Because their bones are of a cartilaginous character, and, indeed, are not fully formed.

is at all correct in principle. If the purpose of the spring, as asserted by some makers, is to support the arch of the foot, then the principle is totally wrong. The arch of the foot, of itself, is a natural spring; and who ever heard of supporting a spring? As well suggest, as one writer puts it, the placing of blocks between the elliptic springs of a carriage in order to support them! For feet with a broken-down arch, the assistance of artificial springs may prove very beneficial, but it certainly does seem absurd to speak of supporting the arch of the foot by springs. It should not be hampered in its functions at all, but have the freest play possible. When the spring is so nicely adjusted as to give to every action of the foot, and to assist in keeping the sole close to the foot at its waist, there is a distinct advantage in its use; but until wholesale manufacturers learn to rightly use the springs, and their workmen to properly fix them without firmly fastening each end, they had better abandon their use altogether in the construction of hygienic footgear.

The desired flexibility at the waist may be obtained in another and better way, that is, by abandoning the use of the shank altogether, and by skiving the sole in such a manner as to reduce it at its edges and all parts, excepting at those which could be touched by a short shank placed towards the outer edge. Of course, this is only possible where a good sole is used; but some soles do not require any reducing.

So far, then, we have treated of the longitudinal arch; we have now to treat of the relation of the tranverse arch upon the form of footgear. As the action of the longitudinal arch tends to lengthen the foot, so does the action of the transverse arch tend to increase the breadth of the foot. It is in every respect an arch, as is the arch at the waist, and if it is correct to support the arch at the waist, then it is correct also—nay, desirable—that the arch of the forepart should be supported. Indeed, some attempts have been made to this end; the principle being the invention of an American, Dr. Plumer. He patented a last, of which one characteristic "consisted in a hollowing out, or concaving, of the bottom of the sole from the heel forward to the toe, but mostly through the ball. This hollow was designed to be filled up with leather in making the boots, so as to leave the bottom flat, while inside it would be rounded upward. The object of this change in the shape of the last was to make it conform to the shape of the foot, which it does very

closely. But at the same time, so far as it has any effect upon the foot at all, it has an injurious one. The form of the sole of the foot at this place is one that ought not to be conformed to by the sole of the boot." As we have before said, "there is a low arch transversely of the foot, from the ball of the great toe to that of the little one, its two opposite resting points. To raise the sole under it is like supporting an arch in the middle, which would be absurd."*

Although the last should be made slightly to this transverse arch, yet the concavity must not be so great as to render the convexity of the sole injurious to the action of this part of the foot as an arch.

Such, then, are the additional mechanical principles to be regarded by the hygienic bootmaker, and which were referred to in the early part of this chapter. There are some physical functions of the foot, however, to which even greater attention must be paid.

It was thought by the old anatomists that life consisted in the prevention of waste. We know now, however, that life consists, on the contrary, of waste and repair. This wasting and repairing is at all times accompanied by the evolution of heat, so much so, in fact, that it has been said that "heat is life," so demonstrative of life is it. The foot is but a part of the body, and the laws which regulate the waste and repair of the muscle, tissues, and bones of the other parts of the body regulate the waste and repair of the tissues of the foot.†

In every action a certain amount of physical loss is sustained, which must be renewed by the blood in its circulation; but that which we desire to make plain is that in these processes of the wasting and repairing of the tissues heat is evolved; that the temperature of the foot, as of other parts of the body, is regulated by the skin as well as by the organs of circulation; that the skin keeps down the temperature through the agency of the perspiration, by which evaporation is promoted in a ratio proportionate to the surplus heat generated—the latter by distributing it uniformly throughout the body. It is the evaporation which keeps down the accumulating heat.‡

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* "Dress and Care of the Feet," pp. 81-2.

† For a brilliant yet simple elucidation of this important subject, the student should read the remarkable little treatise by Prof. Michael Foster on "Physiology," price 1s.

‡ Experiment: Place two iron saucepans on a fire, the one empty, the other full of water. The empty saucepan will quickly

If this evaporation be retarded by the form of the footgear, injury must inevitably result to the health.

But the skin is also an organ of excretion and absorption, and this fact gives us further information as to the indispensable conditions for a healthy foot-covering. As we have before said, it excretes perspiration or sweat, but it must be remembered that this transparent liquid contains several of the waste products of the body, such as carbonic acid, urea, etc. Thus, we have additional evidence that the prevention of the insensible perspiration of the foot is attended with great danger to the whole organism. In walking a greater amount of perspiration is excreted on account of the extra amount of waste occurring; therefore, it is of still higher importance that boots and shoes intended for walking purposes should be constructed on such a system as not to prevent the free excretion of these waste and injurious products.

But the skin of the foot absorbs; it respires, it breathes. That is to say, it absorbs or takes in those parts of the atmosphere which are of vital importance to the health of the body, and it excretes or gives out those gases which are injurious to the body's health.*

These physical functions of the foot, then, must be regarded in the construction of hygienic footgear, and hence the utilisation of substances which are entirely damp-resisting must be strictly forbidden in the manufacture of such goods. We see advertisements of goods which are "warranted entirely waterproof, and hygienic in shape." A waterproof boot for all usual purposes can never be a hygienic boot; for that which keeps the wet out must of necessity transgress an important hygienic law which forbids that the clothing should be of such a form as to prevent the ready evaporation of the perspiration. It is allowable to lessen the rapidity of the escape of this perspiration, as it is by this action alone that clothing affords us warmth in the colder weather, but that its escape should be altogether prevented by clothing the foot in an entirely waterproof material is a direct violation of all the laws of physiology and

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become red-hot. The other will become no hotter than boiling water, until the water has all boiled away, and it will then quickly become red-hot, like the former one. The heat has been regulated—that is, kept down—and made uniform by the vapour carried off from the boiling water.

* The skin, like the lungs, gives off carbonic acid, and absorbs oxygen, and it also, like the kidneys, gives off urea.

hygiene.* We assert on the authority of science that it is even not injurious for the feet to get wet, provided the coverings are of a suitable nature, or that the healthy ability to resist the effects of such wetting is not overbalanced. In so far as the conditions under which the feet are clothed are unhealthy and artificial, so far will this capability to resist the effects of damp-footedness be limited. It is apparent that, were the feet kept in as natural a condition as the hands, no more evil results would occur from wetting the feet than from wetting the hands. The difference in effect of dampness on the two parts is entirely the result of a too artificial system of foot clothing, and although, of course, we do not recommend the primitive fashion of dispensing with footgear entirely, yet we have to remember that the gear which allows the exercise of all the functions of the foot which are possible in the bare feet, and which assists to avoid the evils consequent on bare-footedness, must be considered the most hygienic.†

We have now considered in this and previous chapters the mechanical and physical functions of the foot to which special attention must be paid in the construction of hygienic footgear. Before the practical application of these principles is referred to, a short consideration of the purpose of the heel of a boot may not be out of place.

It has been often argued that heels are entirely useless; that were there a necessity in the human economy for a heel to the foot the same order that furnished us with toes would have furnished a heel also. The argument would be correct were we all born, or did we all live, under natural and not artificial conditions. Unfortunately, such is not the case, and, seeing such, it would be equally logical to argue that man has no need of clothes as to argue that he has no need for a heel to his footgear. Though we have no desire to exaggerate

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* We could give evidence, in regard to cases which have occurred in our own experience, that the direct cause of actual disease has been the wearing of indiarubber footgear and footgear in which indiarubber and enamelled leathers have been used.

† The editor of Camper's Essay on the "Best Form of Shoe" was not so correct as he imagined in improving upon the remark of Mr. Locke, "that children's shoes should be made very thin, that they may thus be more easily wetted," by saying that Locke's reason will have no credit in the present age, as we are now far enough advanced in knowledge to appreciate the advantage of dry, warm feet. (See page 33, Dowie's edition.)

the use of the heel, yet undoubtedly some arguments may be adduced in its favour.

It is to be remembered that under present conditions of city and town life we have many inequalities of surface to contend with in walking. Now, in the natural state of the foot, the line of its axis in walking is straight along the ground. It is possible, by the addition of a moderate amount of heel to the boot, to raise the centre of the foot's axis, with this advantage: That whereas in the normal position the foot is brought into direct contact with any inequalities of the surface, by raising the centre the line of the foot's axis is sufficiently heightened to clear such inequalities. Therefore, rather than being useless, heels have a distinct use, which ought to be regarded. It is necessary, however, that the heel should be used without abusing it. If it is continued above an inch and a quarter the heel has a tendency to cause the astragalus to slip beyond its limits over the calcaneum, to depress the remaining tarsals, and to thereby cause a most painful form of flat foot.

By the consideration of the laws of hygiene in relation to footgear, we find that the following are the indispensable conditions of a healthy foot-covering:—

1.—Sole so shaped as to allow of the healthy action of the foot.

2.—Boot so shaped as to allow of free action to the muscles.

3.—That the boot must be of such additional length beyond the length of the foot as to allow of the elongation caused by the flattening of the longitudinal arch.

4.—That the boot must fit at the ankle and instep with that degree of tightness as to prevent the foot slipping forward therein.

5.—That the line of greatest flexion in the boot must be in an oblique direction from a point immediately behind the fulcrum point of the foot in the action of walking.

6.—That the shank must be disposed only to the centre of the waist and towards its outer side.

7.—That provision must be made that the natural means for equalising the temperature of the foot is not retarded.

8.—That provision must be made in the boot in order to allow of the escape of the waste products of the foot.

9.—That a low heel should be provided in order to avoid inequalities of the surface.

It is our purpose now to consider such questions, bearing on the shapes and the materials to be adopted in order to fulfil these conditions in actual footgear as have

not been dealt with in the previous portion of this work, but which have been included in the foregoing list of conditions.

The main conditions unconsidered are those numbered 7 and 8.

The physical means by which the equable temperature of the foot is maintained have been treated of; and it was shown that the perspiration, or "sweat," was an important factor in maintaining this equable temperature, and that therefore its escape should not be retarded beyond the degree necessary to secure extra warmth to the skin during cold weather; that this perspiration contained the waste products of the tissues and was therefore an additional reason that the escape of the vapour or liquid should be as free as possible.

The question occurs, then: "What materials, and what conditions as to coverings, most readily and effectually allow of the escape of the perspiration and of the noxious waste products of the tissues contained in it?"

In many classes of boots various combinations of leather with caoutchouc or indiarubber are employed. Leather itself is pervious to the perspiration; but, as it is well known, caoutchouc is not. Being of such a nature, it should on no account be employed in the manufacture of hygienic footgear. Sometimes caoutchouc is reduced to a solution by pouring ether, oil of turpentine, or oil of coal-tar upon it. This solution is employed for waterproofing fabrics, and these fabrics are frequently placed between the soles and even between the upper and the lining of boots and shoes to keep the water out. Now, any material which effectually prevents the passage of the water inwards must inevitably prevent its escape outwards; and, although it may be intended to keep the feet dry by this means, the result must be that the feet are more severely and dangerously robbed of their heat by their own perspiration, and are continually in direct contact with their own noxious waste products, and thus receive more injury than by the possible entrance of any outside dampness.* The use of

* Some thirty years back it was all the rage to make prunella boots, both for ladies' and gentlemen's wear, with a waterproof middle lining. The boots were stood in water to show their waterproof qualities. The then Bishop of London ordered his bootmaker to construct a pair of these waterproof prunella boots for his—the Bishop's—own feet. The order was not so satisfactory, as the sequel will show. The boots were made; his Lordship wore them for the first time on a wet day, and, behold! his hose

indiarubber and gutta-percha, then, must be strictly avoided, as they tend to keep the feet wet by preventing the proper evaporation of the perspiration.

If it is desired to render the boot as waterproof as is consistent with the health of the foot, cork should be inserted between the outer and inner sole; and although practically cork is not waterproof, and allows of the passage of the water through its pores, yet by the manner of its disposal the entrance of water detrimental to the health is prevented, whilst the vapour of the foot is allowed to pass off freely.

Given two sets of orifices—the first to consist of four with a total diameter of two inches, the second to consist of one hundred with the same total diameter, water would pass much less rapidly through the first than through the second set.

The pores of a cork, as a rule, are small in diameter (and only cork of this fine, porous nature should be selected for the purposes of boot manufacture), and, therefore, though the cork will allow of the passage of fluid through its substance, yet it allows but the smallest particles possible through at one time. Now, all attempts at waterproofing should be founded on this principle—to allow entrance to as small a particle of water as is possible at one time; for the whole of the ill-effects of damp feet are in consequence of the loss of heat to the body involved in evaporating the extra water; and if the animal heat is naturally insufficient to cope with this extra strain, a bad cold, or inflammation, or something of that nature, will be the sure consequence. But if this strain on the animal heat is reduced by the lowness of the demand (by allowing but a small amount of dampness through at a time), then organisms even naturally deficient in heat may healthfully resist it. The amount of animal heat necessary to evaporate such small quantities of water makes no serious demand upon the body, and consequently no serious results occur. Cork also lessens the rapidity of the escape of the animal heat, and is on that account, therefore, admirably adapted for use in the manufacture of hygienic boots for winter wear. Let it be clearly understood, cork does not pre-

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and feet were as wet as if they had recently been dipped in a pool of water. The necessary complaints of the dishonesty (?) of the bootmaker were lodged, but the whole reason of it was that the boot, being really waterproof, prevented the escape of the perspiration.

vent the escape of the heat, it but lessens its rapidity of escape—a far different thing. In winter it is desirable to lessen the rapidity of the escape of the bodily heat, not that the temperature of the body is actually lower, but because the cold atmosphere drives the circulation inwards, and therefore renders the skin itself colder. By retarding the escape of the heat the skin is thus warmed, whilst the additional excretory function devolves upon the kidneys.

But the materials of which the uppers may be made possess different properties and bear a different relation to this perspiration. Thus we know that cotton and many vegetable fibres have the unenviable property of attracting and retaining the malodorous exhalations of the body. Cotton and linen are conductors of heat, and therefore rob the body in an unnecessary degree of its natural warmth. Although we admit that vegetable fibres have this attractive property, yet more evidence than we at present possess must be adduced to prove that the property of vegetable fibres has any serious effect upon the health of the body.

It is upon this well-known property of vegetable fibres that Dr. Jaeger founds all his arguments against our modern methods of dress, and also of clothing the feet. As an alternative he proposes the universal use of wool for all articles of clothing, including the clothing of the foot. Whatever may be said for Dr. Jaeger's woollen system as a whole (and a great deal can be said in its favour), yet one must admit that "Dr. Jaeger's sanitary boots and shoes," in so far as they are made in accord with the principles of Dr. Jaeger, are not "everything that could be desired." They are certainly less elegant than the article made of leather, and it is somewhat hard to understand wherein it is impossible to adapt the ordinary leather boot to the very strictest demands even of Dr. Jaeger's system; for Dr. Jaeger admits that all kinds of animal wool and hair and leather (when properly dressed) have a healthy influence rather than otherwise upon the foot.

The principle on which Dr. Jaeger forms his boots may prove instructive even to long-established manufacturers, and although they are by no means ideal hygienic boots, yet they possess some peculiarities which it would be advantageous, with modifications, to adopt.

The original Jaeger boots are made at the upper part either entirely of wool, or, to use the Germanic phrase

of Dr. Jaeger, with a leather equipment, which equipment is a narrow ogee golosh. The insole is of leather, perforated, and covered with a wool felt sock which is removable. A ventilation is supposed to be effected by a small hole in the heel communicating the inner sole perforations with the outer air.* In reality, however, it does nothing of the sort.

Now, in the usual boot of leather, the only point that does not agree with the woollen theory is the lining, when of linen or cotton; and probably the most important point of the lining is the sock. Nearly everyone knows the effect of the perspiration upon the ordinary insole; when copious, it speedily destroys the leather, causing it to crack, rendering it unlevel and uncomfortable to the foot. Now, it would appear to be possible to successfully embody the Jaeger insole in ordinary leather boots and shoes—that is to say, a perforated woollen innersole, which should be interchangeable, might be made with every pair of hygienic boots or shoes. It is not recommended to adapt the ventilating arrangement, because, like nearly all such attempts, it is more ornamental than useful. If ventilation is to be afforded to boots and shoes, some mechanical arrangement must be supplied to distribute the air, and until this can be successfully done it is almost useless to attempt to ventilate.

Linings, other than linen or cotton, either of wool or, better, of chamois leather, or of russet calf, should be fitted to hygienic boots. It may readily be understood that a lining of pure, "loosely-woven" wool would not prove very serviceable, and there is no good reason why the needless expense of pure wool should be incurred, when chamois leather of a good quality will answer every purpose. Indeed, a boot constructed with this perforated woollen or chamois leather insole, with an upper of buckskin, and lined with chamois leather, presents to our mind the highest ideal of hygienic footgear.

To again summarise, we would once more remark that on no account should the free action of the skin of the foot be interfered with by insanitary linings; that the linings should be of a substance of low heat-conducting powers; that the upper leather should be of the same low heat-conducting nature; that if it is desired to

* For a full description of Dr. Jaeger's system in regard to the feet, the student is recommended to procure Dr. Jaeger's "Essays on Health Culture," Part III.—"The Boot or Shoe," 41-44 Fore-street, 1s.

afford extra protection against the entrance of water to winter boots, that cork, and not caoutchouc, should be employed.

In hygienic footgear it should be sought to practically exemplify the whole of the principles inculcated in treating of the separate processes; and if such principles, together with those more especially referred to in this chapter, are practically embodied, it may be said, with no fear of contradiction, that the statement of Carlyle, that we have a "public suffering much in its feet," will be, like some other statements of the "Sage of Chelsea," no longer true.

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## QUESTIONS FOR CHAPTER XIV.

1.—State the conditions that should regulate that the boot should be longer than the foot.

2.—At what point is the greatest flexion of the foot?

3.—How is it desirable to shape the shank?

4.—How should a steel shank be fitted?

5.—State the physical functions of the foot demanding the attention of the bootmaker.

## CHAPTER XV.

### On Raw Materials.

Authorities:—For leather, mainly C. T. Davies' "Leather Manufacture" and Proctor's "Tanning"; for "cotton," "silk," etc., see the articles in "Chambers's Encyclopædia" or "Encyclopædia Britannica"; for lasts and the wood of which they are made, see Mr. Tebbutt's hand-book.

In the whole of the previous chapters, the manipulation of the raw materials into boots and shoes, and the principles on which such manipulation depends, have usually been dealt with without reference to any particular materials, and without any detailed treatment as to the origin and mode of preparation of the various agents employed.

A knowledge of the various raw materials is of much importance to the practical manufacturer, as the quality of the various substances and materials employed in the different processes determines, in a very large degree, the success of his manufactures.

In this chapter it is intended to deal broadly, but adequately, with the question, and in such a manner that the chapter shall not only serve to complete the course of instruction necessary for the technological examinations, but that it shall also be of interest to the general reader.

In considering raw materials, it is necessary that the processes of the trade should be classified in such a manner as to render such consideration easy. The classification here inserted is drawn up according to the order in which primary substances are used in the trade.

1.—Lasts: Woods employed, etc.
2.—Linings: A general resume of this division.
3.—Upper Leather: Theory of currying; sources of hides, etc.
4.—Closing Agents: Threads—cotton, silk, etc.
5.—Bottom Stuff: Theory of tanning; tanning agents, etc.
6.—Making Agents: Threads, rivets, screw wire, etc.

For machine-made work the lasts are of iron; for

hand-made work, of wood. Of iron, very little need be said, the wooden last being most within the province of boot manufacture. The models from which the iron lasts are cast are made of wood, and the shape and style of the resulting iron lasts depend upon the shape and style of the wooden model, and it is upon the preparation of the wooden model that the boot manufacturer's attention must be concentrated, so far as the process of last-making is concerned—the casting being a process which may be safely left to the ironfounder. There are three distinct kinds of woods most adapted for the making of lasts—viz., beech, hornbeam, and maple.

The beech is a hardy, deciduous tree, found in northern latitudes. It is indigenous to England, and is most plentiful in Buckinghamshire. The colour of the wood is of all shades, from light brown to a brownish black, but the lighter colours are used for last-making purposes. It is a wood that is easily worked, though somewhat brittle. Another advantage is that of a fine, straight grain.

Hornbeam is an American wood, of great strength and toughness, and fine to handle and work. It is of a close, hard grain, and is white in colour. It is probably the most serviceable wood for last-making, as it withstands a large amount of wear.

Maple is chiefly grown in Prince Edward's Island, North America. In colour it is lightish yellow. Its grain is very close, but gritty, this grittiness rendering it much harder to work, and necessitating greater skill in the use of tools by the workman.

Beech is used in England, hornbeam on the Continent, and also, with maple, in America. It is a disputed question as to which is best, each last-maker, of course, preferring that to which he is most accustomed, but the dispute would appear to be between beech and hornbeam, and the balance of favour seems to be on the side of beech. Hornbeam is the most expensive, but wears the longest, which is greatly in its favour. Beech also wears well, and is, moreover, the cheapest. Its general qualification for the purposes of last-making renders it most in demand, and most in favour for that purpose.

As a guide to the weight of these woods a scale of the approximate specific gravity* is here given :—

* Specific gravity is defined by the "ratio" of the weight of a body to the weight of an equal volume or bulk of some other body taken as the standard or unit.

| Wood. | Specific Gravity. |
|---|---|
| Beech ... ... ... ... ... ... | .696 |
| Hornbeam ... ... ... ... ... ... | .770 |
| Maple ... ... ... ... ... ... | .754 |

## LININGS.

Linings, as here considered, are of linen. Linen is a fabric woven from the fibre of the flax plant. Flax is an annual plant about two or three feet high, and is cultivated in temperate and sub-tropical regions.

After flowering, the plants are cut and then dried in the sun, and subjected to a process called "retting" to remove resinous substances and to separate woody portions of the stem. It is next steeped in water to further this process. The fibres thus set free are dried and then "scutched," that is, beaten with a wooden implement to complete the separation of the fibres. After this the fibres are combed or heckled, and then passed to the spinner.

In weaving, two things have to be considered, viz., the warp and the woof. The warp consists of those threads that extend lengthways of the loom, and the woof or weft is those threads which cross the width of the warp, interlacing and binding it. It is upon the manner of interlacing, and the strength of warp and weft, that the quality of linings depends. As a matter of fact, the strength of the material lies in the warp, the threads of the weft only serving to keep the threads of the warp together. In purchasing linen for linings, care should be exercised in choosing that kind which is not loose and open, or too stretchy. A highly finished face should be viewed with suspicion lest the linen be "loaded" or stuffed with size. Such dressing is most detrimental to the quality of the material.

## UPPER LEATHERS.

Upper leathers, when curried, are the skins of those animals which are best qualified to produce leather of a light, soft nature, such as the calf, sheep, goat, deer, etc. The quality depends a great deal upon the health and age of the animal. Those animal skins that are used for the manufacture of upper leathers, when in the raw state are mostly referred to as "skins," those that are used in the manufacture of bottom leather are known as "hides." The skins which are most used for upper leathers come from the calf, sheep, goat, kid,

seal, deer, and from the majority of the smaller or younger animals.

Upper leathers may be dressed either after the process of tanning—as in leathers of which waxed calf is a type—or after the process of "tawing," as in the case of calf kids, etc., or, further, the skins may be prepared by simply working them a long time with fat, as with leather of the nature of chamois leather. The Indians convert the skins of animals into soft leathers by merely kneading them with the brains of animals steeped in hot water, until the fat contained by the brains is absorbed by the skin. In the preparation of waxed calf, the skins are first unhaired and tanned, then partially dried either in the air or by means of a hydraulic press. The loose flesh pared off, they are next worked in a wet state with wooden pestles or in a drum-tumbler. They are then worked with a sleeker, flesh side upwards, and afterwards washed. The grain side has next to be treated. The bloom from the tanning is scoured out by means of a stone, after which the skin is washed on the grain side, and also worked with the sleeking iron. After re-setting, the skins are prepared for treatment with oil and fats, which render them pliable and supple, and partly impervious to water. The skins are oiled on the grain side first, followed two or three days after by the oiling on the flesh. The oiling on the flesh is accomplished by extending the skins on a marble table and applying the grease by means of a pad. The skins are next dried at a moderate temperature, after which the surplus oil is removed from both flesh and grain. The grain is now finally stoned and sleeked and the skin grained by rubbing it under a knob covered with cork. The flesh is now covered with a marvellous conglomeration of lampblack, linseed oil, fish oil, tallow, wax, and treacle. This compound is applied with a brush and allowed to dry for a few days, when the skins are finally treated with a glue size.

With calf kids the process is different, for, instead of being tanned, the skins are tawed, the process depending upon the action of the alum and common salt upon the skin. The calf skin is unhaired and fleshed in the usual manner, then treated with dogs' dung, and afterwards cleansed with a bran drench. The action of the dogs' dung, or "bate," as it is termed, is probably a putrefactive or fermentative one. The fæces in carnivorous animals, as of the dog, are frequently of lime or

magnesia, and lime phosphate is known to be quite inert. The skin has now to be treated with a mixture of alum and salt, when, after drying, it is worked with a mixture of oil, flour, and egg-yolk. After draining, the skins are dried at a high temperature. After a further wetting and shaving the skins are often redressed with the oil, flour, and egg composition.

Thus far the skins are white. It is now necessary to dye them black. To this end urine is employed, or a mixture of bichromate of potash with urine, to prepare the skins to receive the colour. The dyeing agent employed is an infusion of logwood, and the colour is fixed by a weak wash of iron liquor. After drying, the grain is dressed with an oily composition, and, to complete the process, the skin is ironed with a laundress's iron.

Glove kids are dressed in a similar manner to calf kids. The minutiæ of the processes, however, are different, though the principles underlying these processes are identical. The skins, when softened, are unhaired. Great care has to be exercised in the liming in order to remove the fat, as the presence of fat in the skin prevents the proper action of the dyeing agent. After being fleshed and washed, the skins are treated with a "bate" of dogs' dung. Next they are stretched and worked upon the flesh and grain sides, after which they are again washed and cleansed in various manners, and treated with alum, common salt, and egg-yolks in the form of a thin paste.

They are next prepared for dyeing. This process could be accomplished either by plunging the skins into a dye-bath, or by treating the skin first with an agent to "bite" the colour in, then with the dye itself, and lastly with some fixing salt. Such are the general principles of the methods of preparing upper leather, and it will be seen from the above descriptions that the various performances are most complex, and depend for their success upon very careful and accurate manipulation.

The following information in regard to the origin of the various leathers and their adaptability for various purposes should be specially studied by the student:—

Calf Skins of the best sort are produced in France. The strongest and most suitable for cheaper work are manufactured in England. It is probably the most extensively used of any one description of leather for boots and shoes.

Sheep Skins are applied to a great variety of purposes.

Being low in wear-resisting properties, they are not well adapted for the external parts of footgear. They are principally used as linings for cheap work. When sheep skins are tanned with bark they are known in commerce as basils. When split they are mostly worked up as roan skins or imitation morocco.

Goat Skins are imported from Cape Colony, India, and Switzerland—the Swiss kind being the most excellent. Goat skin, tanned with sumach, and dyed on the grain side, constitutes real morocco leather. It is much favoured for ladies' work and gentlemen's slippers. Goat skins are far superior to sheep in appearance, strength, and wearing qualities.

Calf kid is principally used for ladies' work, though it is extensively used as well in nearly all descriptions of gentlemen's work. It is the skin of the calf dressed according to the principles used in the production of glace and glove kids.

Kips, as a title, is generally understood to refer to a class of skins obtainable from animals between the cow and calf ages. This may have been the case when the term was originally introduced, and it was probably adopted to describe, by a general and specific name, the skins which were obtained from all descriptions of young cattle. The definition, however, seems now to include skins from animals of all ages, size and substance being regarded more than youth and quality. The leather so named is dressed to imitate calf; is hard as a rule, with little or no stretch.

English Kips are chance skins of calves who have died without being slaughtered. They are usually blood-bound and inferior, so are called English kips to distinguish them from properly slaughtered animals.

Cordovan was first manufactured at Cordova, in Spain —hence its name.* It is sometimes called Spanish leather. It was then used principally for making the leather doublets worn by men-at-arms to prevent the joints of their armour from chafing the body.

Crupp is made from the cross-pieces of horse-butts, the grain being removed by splitting. It appears to be so called because it is just that part of the skin of the

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* Some trace the origin of the word to the old name for the shoemaker—Cordwainer. Such an etymon, however, appears very far-fetched. The idea that the leather obtained its name from the place of its first manufacture is much more reasonable.

horse that the crupper-strap of the harness crosses to the tail.

Memels or Levants.—This refers to a mode of dressing as well as to a range of leathers. The skins, however, commonly known as memels or levants are the pelts principally of the calf and goat; while the best pelts of the latter, as mentioned elsewhere, are converted into moroccos of one sort or the other.

An interesting account of this leather was some time ago published, in which it was stated that the use of the term "Levant" arose from a combination of circumstances attendant upon an effort to convert some goat skins imported from the East into Strasburg moroccos. The skins were dressed in the usual way, and passed through the process of the glazing wheel with so unsatisfactory a result that they were rejected as being unfit for the purpose intended—the grain of the leather standing up in bold pebbles, after all attempts had been made to secure the necessary straight flat grain required. The goods were offered for sale in that condition, when they were speedily taken up and became rapidly popular.

Peal's Patent.—This leather, which for years has been used in the making of riding and hunting boots, is much stouter than the ordinary patent calf, but it has not the brightness of that material, there being a slight oily dulness in its appearance.

It wears exceedingly well, and, of course, is waterproof. The secret of its manufacture is known only to to the manufacturers and proprietors, Messrs. Peal, military bootmakers, Oxford-street, London, W., and it is very difficult to be obtained by any other bootmaker. Instead of preparing and enamelling the whole skin, the legs and fronts are shaped as required previous to their being enamelled. The blocking and varnishing process is carried out by the firm at their premises at Ealing.

Enamelled or Patent Leather is produced from the skins of the ox, the calf, etc., by coating them after they have been curried with a sort of paint composed (for black) of linseed oil, lamp black, and Prussian blue, well ground together. The English practice is to nail the skins, when dry, on large smooth boards, fitted to slide in and out of stoves maintained at a very high temperature—160deg. to 170deg. F. Each coating of the paint is allowed to dry in the stoves before the next is applied. The number of coatings depends upon the

kind of skin under treatment, and the purpose for which it is intended. The surface of every coat is rubbed smooth with pumice, and finally finished with a coat of oil varnish. This branch of leather manufacture does not reach its highest perfection in England; it is carried on to the largest extent in Germany and France. The greater perfection of the French and German manufactures is accounted for by English leather dressers from the fact that in those foreign countries the heat of the sun can be used to dry some of the coating; but it is highly probable that our comparative failure to dress enamelled and patent leather is due to some other causes than this.

The name "enamelled" is generally applied when the leathers are finished with a roughened or grained surface, and patent or "japanned" are the terms used when the leather is smooth.

## CLOSING AGENTS.

In the closing of uppers thread is the all-important agent. There are three kinds now used in boot and shoe manufacturing, all three of which are variously used in closing. They are silk, linen, and cotton.

Cotton, formerly only used for stitching woven material, such as for underclothing, has of late years created quite a stir in boot manufacturing circles. The use of cotton as a closing agent is an American innovation, and with a characteristic energy it has been well "pushed" by Brother Jonathan.

It is procured from the seed of the cotton-tree, cultivated in sub-tropical and tropical regions. The cotton is grown and cultivated usually in fields, and is from fifteen to twenty feet high. The colours of the flowers are red and yellow. Attention is carefully paid to the plants until the blossoms appear. The flowers are succeeded by capsules, which open when ripe, disclosing the cotton-covered seeds, which are immediately removed and sent to a mill, where, by the use of what is known as a "gin," the cotton is separated from the seed.

The after operations of cleaning and spinning are similar in principle to the preparation of linen and silk threads—thread being, to put it simply, the twisted filaments of the various raw materials. Cotton thread has a hard, smooth surface, and little or no stretch. It is claimed for it that its advantage lies in its capability to withstand friction; but it is brittle in wear and apt to

snap, while its pulling strength is inferior to that of linen or silk. This being so, the elasticity necessary to a good seam is given (in closing seams with cotton) by using the chain-stitch machine—a machine against which there is much objection on the part of machinists on account of the liability of the seam to unravel. Altogether, cotton, as yet, has not recommended itself to English manufacturers, and probably will not do so until the thread itself has been much improved in pulling strength and pliancy, in addition to the advantage it already possesses with regard to friction.

Linen thread, made from flax, is much used as the under thread in shuttle machines. Its use is not to be recommended as giving the best seam, though it is certainly cheaper; but where the upper thread is of silk there is a lack of affinity between the two that is not of the greatest advantage to the seam. Waxed linen thread is also used in the closing of certain seams of strong work as a supplemental source of strength. It is generally seen as a middle row of stitching round goloshes and vamps. It gives a great appearance of strength to the work, but it is doubtful whether it is of any real good. It is a common fault of some manufacturers that they have a tendency to double and treble, and actually in some instances to quadruple, the rows of stitching at certain known weak points, and at parts where the greatest strains are found to take place; and this tendency grows stronger as the work is stouter, they being forgetful or ignorant of the fact that any seeming advantage gained by such additional rows of stitching is more than counterbalanced by the greater weakness of the material caused by the excessive puncturing necessary for the stitching. Seams, if well stitched, never need more than two rows of stitching; and linen, whether waxed or not, is not to be compared to silk in the closing of uppers.

Silk comes into the hands of the manufacturer in the shape of hanks, and when in this state is clogged with the natural gum. These hanks are placed on frames, from which the silk is wound on to "bobbins." Doubling—the next process—consists of winding the silk off a number of these bobbins, joining the filaments of silk thus unwound into the combined form of thread. The "twist" is next put into the thread, the gum and other resinous substances extracted, and the silk dyed. It is in dyeing that the opportunity is given to the manufac-

turer to load and otherwise depreciate the quality of the silk. The last process is that of preparing the silk for sale, either as hanks for hand closing, or on bobbins or reels for machine use.

The matter of spooling has been found to exercise the greatest influence on the silk—the quality of seam it produces, and the appearance of the stitch. The weight of the bobbins is also antagonistic to the export of the prepared market silk abroad. The importance of this question of spooling was first brought into prominence by Mr. J. Keats, in a lecture delivered by him to the Leek Chamber of Commerce, on January 6, 1887. In proof of his contention that the quality of silk was depreciated by the manner in which it was spooled, Mr. Keats said: "A Leicester manufacturer tried in my presence some Lily machine twist—which came off the bobbin in rings—whilst I tried some French white silk, wound lightly on to a spool, and the contrast was simply marvellous. Although I did not so inform my friend, the quality of my French white silk was not half so good as his sample; yet he wanted to know where I got silk that gave such brilliant silver and pearly stitches, beside which his pure Lily, when the stitching was done, looked rough and beady.

"I am convinced that spooling done so tightly as to produce a hard, metallic surface has all and everything to do with the failing repute of silk twist to-day. These are my reasons: The eyes of the perfected sewing machine needles are now oval, and the spooled silk—by reason of the pressure given to the thread when being put upon the spool—presents in section a quadrilateral form; as a consequence, the top and bottom of the needle-eye wear away and fluff up the four corners of the hard-wound silk thread, thereby causing the rough and dull appearance of silk stitching now so generally complained of · whilst, on the other hand, by the present perfected system, the cable-laid cotton thread is, when spun and wound, almost like round wire, and is so enabled to resist the action of spooling, which is adverse to silk.

"Thus silk, through its first and inherent best qualities—pliancy and elasticity—is becoming condemned by and through these principles operating disadvantageously in the one process of spooling."

It must be admitted that the above extract serves to place the matter in a nutshell, and it is no doubt true.

## PASTE.

Paste is also an important closing agent. It is, as everybody is aware, only used for the purpose of sticking together those various parts of the upper where stitching is done, and for this purpose is absolutely indispensable. Whether paste is necessary for the further strengthening of the seam—whether, in fact, it does so—is a moot point. If it is unnecessary for further strengthening, then the paste should only be of such a character as to but temporarily hold the parts together. In any case it should be spread as thin as possible, "cakiness" being bad either way.

Paste of late years has been the cause of much anxiety to manufacturers who feel a praiseworthy concern for the quality of their goods. It has been found that boots —and especially those shipped to arid climates—have not given satisfaction, owing to the paste becoming an element in the destruction of the seams.

This was at first hard to believe, and harder to prove, but it was conclusively settled in an article in "The Boot and Shoe Trades Journal" of December 4, 1886, that the cause of paste being detrimental to leather was the production in the paste of insects that feed upon the leather. This insect, indeed, is known as the "paste beetle," from the attraction floury substances have for it.

As a consequence of this manufacturers sending goods to tropical and sub-tropical climes now insist upon the use of paste other than that made from rye flour. Glue meal and dextrine are now substituted, therefore, for the ordinary paste. As these substitutes set so hard it is necessary to machine the uppers before they have become too dry.

Ordinary rye paste is the cheapest and most effective for general purposes, and is very simple to make, it being only necessary to add sufficient boiling water, and well mix.

The best paste is that made from white flour, though it is more troublesome to make. The manner of mixing is as follows:—Glue is dissolved in water over a fire; while this is dissolving, mix white flour with water until it has the consistency of cream; also mix into this some insect powder, starch, and a little Condy's fluid. Pour the mixture into the dissolved glue, and boil it all together over the fire, stirring meanwhile until it has boiled,

when it is transferred to the jar for use. The insect powder is for preventing insect production in the paste, and the Condy's fluid will keep the paste from turning sour.

## SOLE LEATHER.

Sole leather is the tanned skins of full-grown and large animals. The skins intended to be tanned for sole leather are commercially known as "hides," to distinguish them from those skins of the smaller and younger animals that are curried or dressed for use as upper leather; and the animals whose hides are most generally tanned for sole leather are the ox, buffalo, etc.

Hides are classed into four divisions:—(1) Green hides, fresh from the slaughter-house; (2) dried hides, from Africa, etc.; (3) salted hides, from Australia, etc.; (4) dried salted hides, from South America and West Indies. Green hides are preferred to imported hides, on account of the comparative ease with which they are prepared, in order to bring them into a favourable condition for the pits. The home supply of green hides is not, of course, sufficient for the demand; accordingly it is found necessary to import immense quantities of dried hides. Imported hides are temporarily treated, to prevent putrefaction, by drying in the sun or packing between layers of salt, and hence much trouble is experienced by the tanner in getting them into a satisfactory state for working.

The skin* is of two layers, the epidermis, or scarf skin, and the dermis, or true skin. The skin varies in thickness in different parts of the body. The epidermis is the development of the true or underneath skin, and is never of great thickness, and forms the grain of the leather. The true skin is fibrous in texture, and it is upon this that tannic acid acts in the conversion of skin into leather. If the hide is soaked in water it will swell, but is not dissolved. Boiled with water, the largest part of it will be dissolved, with a resulting liquor that on cooling coagulates into a jelly; this, when dried, forms glue. This glue, however, is not in the hide ready formed, but is a tissue which can be changed into glue by boiling, and is known as gelatinous tissue.

The theory of tanning can be illustrated by a simple chemical experiment. Pour some tincture of galls upon

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* A full description of the skin will be found in the first chapter.

a solution of gelatine,* and a flaky, cloudy precipitate is obtained. This is a combination of the gelatine with the tannin of the tincture of galls. This precipitate is insoluble in water, and may remain in its wet state, exposed to the air, without passing into putrefaction.

It is this action of tannin on gelatine that forms the basis of all the prevalent methods of converting raw animal skins into leather. It is apparent, then, if gelatine and tannin are the elements for the formation of leather from animal skins, that, inasmuch as the tannin is applied to the hide, the gelatine must be a constituent part of the hide.

The gelatine is contained, as far as is at present understood, in the cellular tissue of the hide; and this gelatine in the hide is altered in the process of tanning in exactly the same manner as was the gelatine in the experiment. Gelatine of itself, exposed to the action of the atmosphere, rapidly passes into putrefaction; acted upon by tannin the process of putrefaction is stayed. Thus, then, sole leather is, in fact, the gelatine of the cellular tissue of the hide intimately combined with tannic acid.

Before, however, the hides can be brought directly under the influence of the tanning agent, they have first to undergo a process of preparation. Thus, supposing a fresh hide brought into the tanyard, after a preliminary inspection it is soaked, to bring the hide to its full development, as far as dimension is concerned. If the hide is a salted one it will require longer working; and if a dried hide it will have to go through a prolonged treatment of soaking and working to render it permeable to the fluids that are brought to bear upon it. Hides that are extremely hard and dry are soaked in liquors that have previously soaked softer hides, as the softening properties of "old soaks" are found greater than of clean water.

After this process the hides are next unhaired. To this end they are usually treated with lime. Many methods have been devised for loosening the hair without lime; but yet, up to the present, lime is almost the universal agent—in England, at any rate. The action

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* This solution may be prepared as follows:—Take some good gelatine (such as Nelson's), and place it with sufficient water to cover it in a basin The gelatine will readily absorb the water, and becomes consequently much swollen Place some of the gelatine in a flask; immerse the flask to its neck in boiling water, and the gelatine will rapidly become liquefied.

of the lime upon the hide tends to swell the cells of the outer skin, loosening and dissolving the hair sheaths, so that on scraping with a blunt knife the hair, together with other superfluous matter, is easily removed. The usual method of liming is simply to lay the hides flat in pits containing milk of lime. From these pits, day by day, the hides are removed, and the infusion stirred and plunged to distribute any undissolved lime. After unhairing, the next process is rounding. Under some systems, hides are tanned whole, but usually in England hides are rounded for sole leather.

By rounding is understood the division of the hide into various parts, known to boot manufacturers as the butt, shoulders, bellies, etc.

When the entire hide is divided down the centre, each half is known as a "bend." The hide is now almost ready for the tanning agent. Before, however, it is completely ready, it is necessary to pass the hide through fresh water and other processes, in order to free it from dirt and lime. Now it is ready for the tanning agent.

Presuming the liquor prepared, the butts are suspended by the shoulder across the pits. The butts have to be kept in motion, which is usually done by a mechanical contrivance. They are first treated with a weak liquor, and such treatment is spoken of as in the "suspender liquors." After this treatment they are passed on to the "handlers," where the butts are laid flat in liquors that are frequently varied. After receiving treatment in the "bloomers," they are cleansed in a clear liquor and allowed to drain. The next operation is that of "striking." This is done by a double-handed tool, having a triangular blade, with a tolerably sharp edge. By this process of striking the grain is stretched and smoothed. After a further drying, the butts are slightly oiled, rolled, and occasionally coloured on the grain side, and prepared for the market.

It is of the greatest importance to the really practical boot manufacturer to be able to ascertain the qualities and peculiarities of the leather used in bottoming. And as the different qualities of leather produced mainly depend upon the tanning agents employed, it is necessary to have a general acquaintance with the particular properties and effects of the various tanning agents in general use for the production of sole leathers.

At the present time the methods adopted for convert-

ing animal skins into leather depend upon the action of tannins contained in vegetable substances, or of the extracts from such vegetable substances.

Beyond this method, skins are converted into leather by the action of certain minerals and salts upon the hide. Thus, tanning agents are broadly divisible into vegetable and mineral. The principal vegetable tanning agents in general use are:—Oak-bark, Valonia, Myrabolams, Divi-divi, Mimosa, and Gambier; and though the characters of the different leathers produced by these different vegetable agents are markedly different, yet all depend for their successful action upon the possession or embodiment of a certain percentage of tannin.

The bark of the oak is probably one of the most ancient of tanning materials, and the leather produced by its use has ever been accounted of the highest quality. Leather so produced has a sour smell, peculiar to it alone. Judged from the standpoint of the tanner, oak-bark is deficient, as it is incapable of giving much weight, and for that reason, and also because of the scarcity of the supply in relation to the demand, it is now hardly ever used alone.

Pure bark-tanned leather is becoming gradually extinct, a mixed tannage being found more practically useful. For the boot manufacturer, light, solid leather, such as is produced by oak-bark, is a desideratum. Leather carefully cleansed of lime and treated with oak-bark will be almost cream in colour, but rather soft, and hence hardly suited to resist the usual demands which, in wear, are made upon the sole of the boot. Such leather is eminently well suited for the very best work, where lightness, pliability, and elasticity are specially sought after rather than resistance to wear. But for most purposes it is rarely tanned enough to fully resist dampness. Oak-bark contains on an average from 8 to 12 per cent. of tannin, and from this fact is costly for the tanner to handle.

Valonia is the commercial name of large acorn-cups, grown principally in south-eastern Europe. The average percentage of tannin in valonia is from twenty to thirty. It is generally used in the tannage of large hides, and produces a weighty leather of a yellowish-brown colour.

Myrabolams, the fruit of an Indian tree, contains about 35 per cent. of tannin, and produces a leather

light in weight, yellow in colour, but spongy and soft in texture.

Divi-divi is not in extensive use in tanning on account of its liability to undergo sudden fermentation, staining the leather a dark red colour. It is stronger in tannin than valonia, containing as much as 50 per cent. of tannin. It is obtained principally from South America. The leather tanned by it is of a dark colour, with a peculiar hardness in dry weather; it is horny and hard, and is liable to crack.

Mimosa is obtained from the bark of the Australian acacia; it contains from 20 to 30 per cent. of tannin, and has a different effect according to the strength in which it is used. If used strong it produces a hard, heavy leather, firm of substance, and of a reddish colour.

Gambier, or Terra Japonica, is obtained from the leaves of a plant grown in the Straits Settlements district. The tanning agent is obtained by boiling the leaves of the plant in water, and running the resulting infusion into moulds. It contains about 40 per cent. of tannin, and rapidly penetrates leather. It first came into extensive use for tanning about fifty years back. It was then used as a rapid tanning agent, the liquor being pressed and forced into the pores of the skin in order to hasten the process. Butts so tanned were sold at from 9d. to 10d. per lb. This method of using gambier rapidly brought it into discredit, the leather so produced being very low in quality, and almost black in colour. Gambier, however, now used with an enlightened knowledge, is found useful in the tannage of both light and heavy leather; its use tends to swell the hide, and to produce a thick, porous, soft, and pliable leather. It is generally used in conjunction with other agents, and, as a rule, in the earliest stages of the processes of tanning.

Besides the tanning processes with these vegetable agents, the hide is sometimes treated with the extracts from them; and though, as a general rule, it is not the best tannages that are so treated, yet we have it on the authority of Mr. H. R. Proctor that "in one of the highest-priced tannages of this country extract is used."

## CHROME LEATHER.

Mineral-tanned leather is produced by the action of certain salts upon the hide. The actual principle of the process dates from a remote period. Upper leathers are so acted upon by minerals when laid in a solution of alum and common salt. Tanning sole leathers with minerals is a further development of this principle. Bichromate of potash is the agent that is principally employed, and a high degree of perfection is now obtained in the manufacture of upper leather under this process, though the production of good sole leather by this means is still an unattained art.

In examining leather to ascertain its quality and remunerativeness in the manufacture of boots and shoes, its weight should be one of the principal points considered. Regarding the differences between a pure bark-tanned butt and one of a mixed tannage, the different effects of the various agents must be considered. Colour affords an important clue as to the purity or mixture of the tannage. A section looked at under the microscope, if of pure bark tannage, will show a light-coloured fibrous matter. The lighter the colour, the greater is the probability that the tannage is of pure oak-bark; the darker, the more probability of the tannage being mixed, the particular agent employed being in part determined by the shade of colour visible.

## THREAD, RIVETS, ETC.

Makers' agents consist of—(1) thread, (2) rivets, (3) pegs, and (4) screws and screw-wire. Threads are of linen and cotton. Linen having been dealt with previously, its account need not here be repeated, in so far, at least, as it relates to thread made from flax.

In making and manufacturing, threads are made from hemp. Hemp is a plant that has been cultivated from time immemorial. Its fibre is obtained from the bark, and is separated by prolonged maceration. Hemp is stronger than flax, and generally coarser, and is preferred for seams subjected to much wear, as in the bottom work of boots and shoes. For machine work threads are procured ready made. In hand work the worker makes his threads, according to the substance he is working on, of "strands" of hemp drawn from a ball prepared for that purpose.

Cotton is also advocated for bottoming purposes, as well as for closing uppers. The recommendation is the same, i.e., its capability to withstand the friction consequent upon the continual working of the seam in wear; also the length of time it can resist the action of the weather, in both of which respects it is claimed to be superior to hemp and flax, as well as silk. In hempen threads wax is necessary to bind the thread and keep the twist in, as well as to keep the stitch in position after setting, and thus neutralising the deleterious effects of friction as much as possible; but in using cotton, owing to the advantages claimed for it in this respect, it does not need the addition of wax. In fact, it necessitates the opposite extreme, and requires a lubricant of paraffin and beeswax to render the working easier and cleaner. This way certainly makes it better for the machine, but its advantages for the boot have not yet been made sufficiently and practically obvious to the English manufacturer to render its adoption general.

Rivets are in demand for certain classes of work, though not so much as formerly, owing to the success of the sewing machine. The rivet of boot manufacture is a variety of nail with a conical point, a flat screw-shaped head, and a body slightly screwed upon the surface for better holding purposes. In the Ab-Intra method a rivet is used with a barbed point, this being so because of the rivet being used the reverse way to the ordinary kind. Rivets are of brass and iron. Iron is cheaper and holds better, though in the end it corrodes the leather, owing to the rapidity with which the iron unites with the tannin of the leather. Brass is valuable on account of its non-corrosive properties, and for this reason is preferred to iron, as, having no affinity for any substance in the leather, it is not an active cause of its decay like the iron. Brass does not last so long in wear, and is much dearer to use. Tingles have large, flat heads and thin shanks, being used to fasten the uppers to the inner soles.

Pegs—of wood, principally deal—are made by machinery and used more upon the Continent than in England for the purpose of bottoming. They are still used by hand-workers in the building of heels. Their use has been all but superseded by the rivet.

The screw is one of the firmest connective agents known in mechanics; a whole chapter might be written on its principles, but its advantages over the ordinary

nail and rivet are sufficiently obvious to render such a description here unnecessary. Screws have been rendered obsolete by the introduction of screw wire, worked from a continuous coil from above the machine, as in the Standard Screwer. An account of this improvement may be found in previous and subsequent chapters.

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## QUESTIONS FOR CHAPTER XV.

1.—Enumerate the chief raw materials of the boot manufacturer.

2.—Give a brief account of the proportion of (a) calf kid, (b) wax calf.

3.—What is the difference between tanning and tawing?

4.—How is the worth of a tanning material estimated?

5.—Give the distinguishing characteristics of (a) oak-tanned leather, (b) valonia-tanned.

## CHAPTER XVI.

### A Consideration of Boot and Shoe Machinery.

Authorities:—For American machinery, see the series of articles contributed to the "Boot and Shoe Trades Journal" by Mr. A. F. Randall in 1892; for the economic aspect of the use of American machinery, see Mr. Swaysland's able "Report"; for sewing machinery (uppers), Mr. J. W. Urquhart's "Sewing Machinery" may be consulted, though in reading it one should remember there are other makers of sewing machines than Messrs. Singer.

Boot and shoe machinery may be classed as (a) for the preparation of the uppers; and (b) for the preparation and attachment of the bottoms.

Of the first class, sewing machinery constitutes by far the most important item, and we shall, accordingly, treat of that first.

The essential elements of any stitching mechanism are:—

(a) A needle having its eye near the point, and carrying a bight of thread into and through the material.

(b) A mechanical device beneath the material, by means of which the thread may, whilst underneath the material, be manipulated so as to make a chain, loop, or stitch; or, interwoven with a second or under-thread, form a lock-stitch.

(c) A mechanical device above or beneath the material known as a feeder, by means of which the material may be moved forward the required distance on the completion of each stitch.

Two descriptions of stitches are formed by the modern sewing machines—the one formed by means of interlooping a single thread beneath the material, and known as the chain-stitch; and the second, by interweaving with another thread also beneath the material, and known as the lock-stitch.

Each form of stitch possesses certain advantages. The single thread, or chain-stitch, is very elastic, and is

sooner planted into the material than is the lock-stitch; and as it is generally admitted that it is desirable that the thread should be planted into the material with the least possible friction, chain-stitch machines have an advantage over those making the lock-stitch in this respect. Mr. G. W. Lascell, the author of "King Cotton," has shown the manner in which the thread is worn in passing from the spool to the material in the Wheeler and Wilson machine.

He says: "By exact measurement it is found that the hook of the Wheeler and Wilson machine pulls down 4½ inches of thread, and any stitcher will bear me out in the assertion that one-eighth of an inch is a large average allowance of thread for a single stitch to take up. Now, as there are thirty-six eighths in 4½ inches, it necessarily follows that the 4½ inches of thread passes downwards thirty-six times, and the 'take-up' jerks it upward thirty-six times, which altogether makes exactly seventy-two times that the thread passes through the needle before the stitch is planted in the leather."

Mr. Lascell then considers an objection which might be brought against his reasoning to the effect that if the needle goes down but once to form a stitch, and the "take-up" pulls the thread up, then the thread must pass the needle but twice to complete a stitch. He answers: "We grant all that as being true as to the first stitch; but the second stitch has taken the thread through four times, and the third stitch six times, and the fourth stitch eight times, and the fifth stitch ten times, and so on to the end of the original 4½ inches pulled down to form the first stitch, when the last eighth shall have passed the needle just seventy-two times, and from that on to the end of the spool every identical eighth inch of thread must pass not only through the needle, but through the tension and the various thread-guides leading to the needle, and last, but not least, through the leather also."

Thus it is seen that all the disadvantages which accrue from the delay in planting the thread uninjured into the leather are to be set off against what other advantages the lock-stitch may possess. With the single thread machine of Wilcox and Gibbs, so strongly recommended by Mr. Lascell, the thread is passed from spool to needle with only a nominal amount of friction. The device by means of which this is accomplished is contained in the round casting shown in Fig. I., and

known as the automatic tension. It consists of a thread rest or support, upon which the thread in its passage to the needle is held by a smooth surface ring resting upon the thread by gravity simply, so as to exercise a gentle but continuous pressure thereon, in combination with a thread-clamping device consisting of a stationary support for the thread, and a movable clamping surface, actuated by a spring, for the purpose of firmly holding the thread until the loop is almost or quite drawn up to the material, and then suddenly releasing the thread, leaving only a nominal friction upon it.

With the lock-stitch machines, though the thread has

Fig. I.

to pass through more thread-ways, the stitch is afforded the extra security of being tied, as it were, in the centre of the material, as will be shown. It has a plain and regular appearance, which is the same on both sides of the material.

The lock-stitch machines admit of two classifications —those working with a shuttle, and known as shuttle machines, and those in which the stitch is formed by a rotary hook, and known as rotary hook machines.

The type of shuttle machine we have selected to illustrate our remarks is the Howe. All the other makes of shuttle machines are either improvements on or deviations from the machine originally invented by Howe.

To form a stitch in this type of machine, the needle descends through the material, carrying a portion of the thread with it. When the needle reaches its lowest point in the down stroke it begins, after a short pause, to rise, and in so doing throws out a slack loop. This is the first stage, and so far the upper thread is alone affected.

The formation of a stitch depends, however, upon a manipulation beneath, for, as our second condition has it, there must be "a mechanical device beneath by

means of which the thread is manipulated." This "manipulation beneath" is accomplished in the Howe by a thread-holding shuttle with reciprocating motion, sliding along a smooth race, approaching the point at which the loop is cast out by the rising needle, and passing through it, expanding it while the needle continues rising, interweaving the under thread with the upper and tying a knot, as it were, in the centre of the material being stitched. Thus in the Howe machine is one stitch formed. It is now necessary to understand how the process is continued, and this involves the consideration of our third condition.

In the original machine made by Howe,* in the winter of 1844-45, the material was passed on for the process of stitching by means of a bastard plate, or a plate in which were affixed several pins. On these the material was fixed. Thus it was only possible to stitch in a straight line. The next attempt was with vibrating needles. These also being unsatisfactory, the form of feed known as the "wheel feed" was adopted. This wheel, revolving certain fixed distances at certain fixed periods, caused the material to pass under the needle; and it is by the regulation of the "throw" of this wheel that the length of the stitch is either increased or decreased—the throw being determined by the position of a knob-screw at the end of the centre shaft of the machine.

The diagram (page 177) shows the mechanical arrangements by means of which the stitches are formed and continued in machines of the Howe type. To the right of the machine will be noticed the large fly-wheel, by means of which the power is communicated through the shaft (EE) to the whole of the machine. On this shaft, it will be noticed, a large cylinder is fitted, having two "cams" cut upon its surface. Towards the left side, a smaller wheel with a serrated periphery or roughened edge (marked A) is seen; this is the feed-wheel to which we have before referred. From the centre of the feed-wheel proceeds a small rod (B), resting and working upon a small cam cut upon the extremity of the shaft (E). This rod is kept in position by the spring (D). Attached to the cam on which rod B rests is a small screw, which acts (as will presently be shown) as a stitch regulator.

* It may be interesting to record that the first sewing machine was not made by Howe, but by a carpenter, for the sewing of boot uppers. This machine was at one time on view at the Society of Arts.

At H, a small stud fitted to the table of the machine is shown. Proceeding from this stud is a short arm, working with a friction roller in the cam (F). Also pivoted from the same stud (H) is a second arm, with an upward direction, attached to the shuttle-carrier, the motion being communicated by the action of the first arm working in the cam (F).

In the second cam (G) a longer and an upright arm working in vertical and horizontal positions is shown at J.

It is by the mutual action of these various parts, of

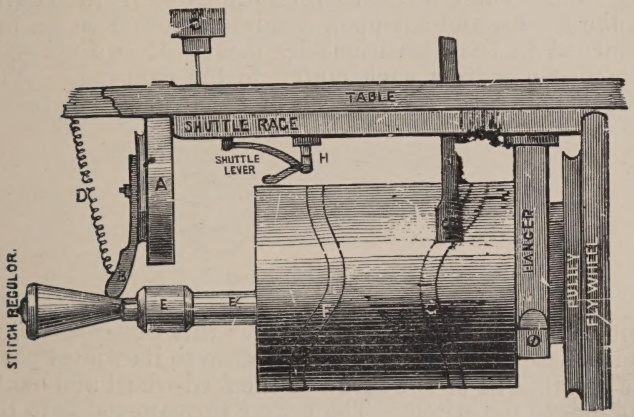



Fig. II.

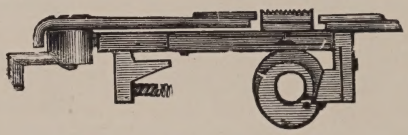
which we shall now treat, that the processes of stitching are accomplished.

The rod (marked J) working in the cam (G) is connected with the needle-arm and working in the cam must have an "eccentric" or deviating nature. Thus it is apparent that, on the revolution of the cylinder, the rod connected with the needle-arm and working in the cam must have a swerving or pendulum motion given to it. Thus, when this rod, by the revolution of the cylinder, is moved out of the perpendicular position, the needle-arm, being attached to it, acquires an upward motion. When, by further revolution of the cylinder, the upright position is again given to the needle-arm, then the needle descends. Thus the actions of the needle are accomplished.

The shuttle is actuated by the revolution of the shaft, through the rod working in the cam (F). As was

before shown by the connection at the stud (H), the motion is again communicated to the upward arm connected with the shuttle-carrier. The ultimate motion, as can be easily seen, is a reciprocating or a backward and forward one. The peculiar shape of the cam, it will be seen, easily imparts such a motion when in revolution.

A rod attached to the feed-wheel acting upon a cam has been previously noticed. The feed-wheel itself is actuated by two clutches, which rise and lift the wheel, as it were, by the action of the rod (B) against the revolving cam. The clutches, which are fitted in the centre of the wheel, and act upon a raised internal ridge, are returned to their positions by means of two springs, attached one from each clutch to the cam-rod. The cam on which the rod works is of a conical shape; there-



"Four-Motion Feed."

fore, it is apparent that the nearer this cam-road (B) is to the base of the cone, and therefore to its widest part, the greater will be the throw of the feed-wheel and hence the longer the stitch. The nearer the cam-rod is to the apex of this cone, and consequently to its narrowest part, the less will be the throw of the feed-wheel, and consequently the shorter will be the resulting stitch.

The Wheeler and Wilson is the best and most perfect type of the Rotating Hook Machine that can be selected. In this machine our second condition is found under a different form to that in the Howe, and in this difference exists the marked peculiarity of the machine. Instead of the reciprocating shuttle, the Wheeler and Wilson has what is known as the "rotating hook and stationary bobbin" as the mechanical device beneath the material by means of which the thread is manipulated so as to make a lock-stitch. In the older forms of the Wheeler and Wilson machines a curved needle was used, but this being found unsuitable for leather work, a straight needle has been substituted, and other improvements made in the machine, adapting it for many descriptions of boot work.

The hook and bobbin in position to form a stitch, the

needle descends to its lowest point and then begins to rise, and in so doing throws out a slack loop. The hook meanwhile has been revolving to meet the needle, and when the needle has risen slightly the hook point is ready to enter the loop thrown out by the rising needle. Continued rotation causes the needle to rise further and the hook to pull out, and expand upon itself, the loop. In doing this, the left side of the loop is drawn behind the spool, whilst still further motion causes the loop to slip off the hook, thus forming the stitch. The feed in the Wheeler and Wilson is of the description known as the "four-motion feed." Of these four motions, the first is a rising and pressing into the material; the second, a forward, carrying the material; the third, a falling; and the fourth, a backward motion.

Thus, to summarise, the stitch in the Howe is formed by—

(a) The needle descending to its lowest point.

(b) Then slightly rising and throwing out a slack loop.

(c) The shuttle shooting through the loop, thus expanded, and interweaving its own thread therewith.

And in the Wheeler and Wilson by the same processes as (a) and (b) in the Howe, but also—

(c) By the hook point revolving to meet the rising needle, and the hook point entering the loop thrown out.

(d) By the continued rotation of the hook causing the expansion of the stitch, drawing the left side of the loop behind the spool.

(e) By still further rotation causing the loop to slip off the hook, and thus forming the stitch—the "take-up" assisting the last process.

Although single-thread machines are not in general use in this country for boot-closing purposes, yet, as they have had an important place in the arguments adduced during the cotton controversy, a short description of their mechanism may be found useful. The Wilcox and Gibbs is probably the best form of a single-thread machine we can select.

In this machine, where the needle descends carrying a bight of thread, the thread is manipulated beneath by means of a rotating hook. This hook is of a peculiar shape, and twists the loops in a fashion which gives the stitch of the Wilcox and Gibbs machine its well-known elasticity. When the loop is seized the needle begins to ascend, and as the hook continues its revolution the loop is twisted once across the path of the needle—

that is to say, the front part of the loop is turned to the back, and vice versa. The loop is now held spread out under the needle-hole until the needle descends, and the hook is enabled to catch another loop, which is twisted similarly to the former one. The hook, by expanding the first, assists to pull the second loop into the material. As is plainly evident, this rotating hook must be of a finely polished and smoothly finished nature, and in the Wilcox and Gibbs machine the looper is of such a nature.

The material is brought wholly under the needle by a feeder provided with three sets of teeth cut upon the one feed-bar. By means of an eccentric cut upon the horizontal shaft, this feed is caused to give four motions at each stitch. The teeth are first pressed into the material, and then the feed-bar moves forward; the feed-bar now falls, and, turning backward to its first position, completes the four motions.

The short groove of the needle must be set towards the point of the Gibbs looper; and to insure this, and also the correct height of the needle, a peculiar arrangement is provided. The stem of the needle is grooved deeply in one side only, this groove corresponding with a steel tongue in the needle-bar hole, so that the needle cannot be very well set otherwise than according to the requirement of the machine.

The "automatic tension," another peculiarity of this machine, has been explained and illustrated in a previous part of this chapter.

One great advantage of the Wilcox and Gibbs machine is the very high rate of speed which may be attained. With steam power it is said to be possible to attain three thousand stitches per minute, while, by foot, one thousand five hundred may probably be given, the work being done with equal perfection at all speeds.

Of course, beyond the machines treated, many other forms of sewing mechanism are adopted in boot manufacture, such as button-hole machines, button sewing-on machines, over-seaming, and wax-thread machines, etc.; but it is unnecessary for the elementary student to have details of these. If a good knowledge of the mechanical principles of the sewing machinery referred to in the course of this chapter be obtained, it will render the comprehension of these subsidiary machines comparatively easy.

In the preparation of the upper numerous other ma-

chines are employed, and these we shall classify as (a) cutting machines, (b) fitting machines.

(a) Lining presses, using a steel cutter the shape of the desired boot, to stamp the linings out, are used by many firms. Cheap leathers are also cut by this machine, but its use is not extensive. Skiving is now performed by ingenious machines, which do the work far cleaner than it is possible to do it by hand. They are of two kinds, the first having a fixed knife, and the second movable ones.

In the fixed knife machines, the leather is brought into contact with the blade by two revolving wheels with serrated peripheries. In the second class of machine the upper leather is passed between two revolving blades, which effectually skive the parts the desired depth. This class of skiving machine appears to answer most admirably. Skiving machines are very useful in preparing the uppers before they are fitted for the sewing machine, being constructed on such principles as to admit of the proper skiving of nearly all descriptions of upper leather, from the lightest glove kid to the stoutest calf.

(b) Fitting machines are used in fitting some descriptions of work, especially cashmere and lasting; but even with this machine the work can be done cheaper by manual labour. The machines depend on the movements of a block through a stencil fitted in a flat bed. This block turns over whatever extra material has been allowed for the purpose, which is secured and smoothed in the case of cashmere work by a warm block, the whole apparatus being worked by means of a treadle.

We now have to shortly consider the machinery used in the preparation and attachment of the bottom stuff. In these we have machines for cutting, rolling, splitting, sewing, screwing, etc.

The prevailing form of cutting press is too well known to need any detailed description of its outlines here. The motion is usually accomplished by two eccentrics connected to a cross bar, which is fixed to the slides at each side of the machine. The movable bed is connected with these slides, and the top bed is arranged so that its distance from the knife may be regulated by the two wheels worked one in each other.

This description of machine is made in several forms —for one man, two, or four men. They are very noisy in the working, and this is a great disadvantage in some

instances. Messrs. Barker, of Birmingham, have invented a press which claims to be a silent one. Its form is different to the ordinary eccentric press, inasmuch as it has a fixed head and the bottom bed is movable. The movement is gained by a worm and pinion, the worm and fly-wheel shaft being cut from a solid steel forging.

The movement on the end of the pinion shaft (immediately above the main shaft) is turned on an eccentric with a steel collar shrunk on it to prevent wear. It is from the revolution of this eccentric that the table is raised.

A form of cutting press known as the Revolution press is also coming into greater use, for uppers more than soles. It is run by power, and the motion can be imparted to it and restrained or stopped instantly by placing the foot upon a treadle.

The most modern improvement is, however, the open-end press. As with a sewing machine, "room under the arm" is a point of value, so much more so is this the case with a sole-cutting press. With an open-end press (see figure on page 98) there is less necessity, and very often no necessity at all, for "ranging," and thus the cost of manipulating the leather is reduced.

In the usual pattern of rollers the pressure is applied by weights sliding on levers attached to bars, giving pressure to the top roller. According to the position of the weight upon the lever, so the pressure upon the roller is affected. The rollers should at all times be of either galvanised iron or of gun-metal. Plain iron rollers are rarely used, and should be entirely avoided.

The machines for cutting the channels in the soles for machine-sewn work are constructed with a fixed knife, the sole being carried through the machine by a pair of wheels with serrated peripheries. The pressure is applied by a treadle, and the motion is communicated by a small hand crank.

Machines for reducing the substance of leathers, or for splitting them into equal parts, also for cutting split-lifts and strips for uppers, etc., are now in much use in the trade. The principle of the Upper Leather Splitting Machine is by means of a revolving cylinder to bring the leather into contact with a knife adjusted to the degree it is desired to split the leather. By this means an even severance is secured with but a comparatively simple piece of mechanism.

Where hammered leather is preferred a machine may be obtained for hammering.

Machines for cutting split-lifts are among the most useful of the many machines used in the manufacture of boots and shoes. The principle of the machine is somewhat analagous to the Splitting Machine. In the case of the Split-lift Machine we have two short shafts connected through an iron frame with two small rollers, to which motion is communicated to the other end through a cog-wheel gearing by means of a small hand-wheel. The two small rollers bring the leather into contact with a fixed knife, which so severs the leather that the strip is thicker at its one edge than at its other. It severs the leather, in fact, in a slanting transverse direction, thus producing good split-lifts for rendering the convexity of the seat of the heel level for the first lift.

Machines are designed for cutting leather into strips for beading or for back and front bands. One machine introduced for the latter purposes not only cuts the strips but also grooves the back band, showing the line which the machinist is to take in stitching. It is claimed that "silk is protected in wear by lying in the groove," and that, therefore, this method of cutting back bands by machine process possesses other and greater advantages than the mere expedition of the cutting process.

This class of machine depends upon the united action of a series of circular knives and a roller. Some of the machines for back and front straps cut or make four kinds of straps.

We have now to consider in a general manner the various machines used in attaching the soles, either by sewing or screwing, to the boot or shoe uppers.

The most important of this class is undoubtedly the Blake Sole Sewer. This machine is a distinct triumph of mechanical science, and has done more to revolutionise the trade than all the other machines put together. For its own particular work it is well-nigh a perfect machine, and under the care of an intelligent operator it is rarely out of working order. Its introduction to the English trade marks an epoch in the history of boot and shoe manufacture, and occurred in the year 1859. The principle on which the soles are attached by this machine differs essentially from that practised by the seatsman. For whilst the hand-made work is pro-

duced with both a sewn horizontal seam and a stitched vertical seam, the Blake makes but one class of seam—the vertical—uniting sole, middle sole, upper, and insole. The mechanism, which is of a simple nature, is for the purpose of driving a steel hook of the nature of a crochet hook through the sole, upper, and middle sole, and interlacing a waxed thread fed through the horn of the machine to form a series of loops, which lie in the channel, the insole presenting a regular row of single stitches planted in a slightly oblique direction. The waxed thread is kept at a rather high temperature by means of a gas jet at the base of the revolving horn of the machine; the thread being passed from a reel through this horn, and caught up at each descent of the hook into a series of loops as previously described. It will be observed that the Blake is a chain-stitch machine capable of nearly all classes of work—from the lightest to the stoutest. It is, however, more adapted for stout than for the lightest goods.

The Blake Welt-sewing Machine sews the welt in in the same manner as is done by hand; the holes are first pierced by an awl, and then a curved needle produces the stitch, which is looped on the insole side and single on the welt edge of the seam. The seam produced is not of the best possible description, being rather clumsy, especially on the looped side.

If the welt is sewn in by means of this machine, the sole is attached either by means of the Goodyear or Keats Fair-stitching Machines.

The Goodyear Machine makes a stitch looped in the channel and single on the welt. It makes a very pretty, fine stitch, but the series of chain loops produced in the channel somewhat interferes with the satisfactory appearance of light work. The machine works first with an awl, which pierces the hole into which the needle next passes to form the stitch.

The Keats Fair-stitching Machine is distinct from the former machine in that it produces a lock-stitch. It is almost impossible to distinguish a boot stitched with this machine (without an observance of the insole) from a hand-stitched boot. It is one of the most complicated pieces of mechanism used in the manufacture of boots and shoes. It is very often used in conjunction with the Standard Screw Machine or the Blake Sole Sewer. If with the former, the middle sole is screwed on and the waist is sewn with the Blake Machine. If used with the

Blake only, the insole is then sewn on, the forepart stitched, and the waist sewn with the Blake machine.

The Standard Screwer is much in use, especially for the stouter classes of work. The work made under this machine is screwed by means of a wire on which a screw thread has been cut, being supplied from a coil above the machine. The boot is placed upon a horn in the same manner as under the Blake process. By the action of the machine the screw is turned into the leather, and is cut off automatically to the exact length the substance of the sole of the boot or shoe may require, leaving a completely smooth face on the inner sole side. A boot made under this process is smoother on the insole than are the majority of hand-sewn boots. It is well adapted for the manufacture of all classes of work in which solidity is specially required, though it is also capable f affixing even a light middle sole in a secure manner.

It has not been thought necessary to enter into the details of the mechanical principles of all descriptions of boot and shoe machinery. It is sufficient for the course for which this Manual is intended to be the text-book that so much as is contained in this chapter on machinery be well understood.

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## QUESTIONS FOR CHAPTER XVI.

1.—State the essential elements of a sewing mechanism for stitching uppers.

2.—Show how these are embodied in any type with which you are acquainted.

3.—What is the chief advantage of an open-end press?

4.—What sort of stitch is made by the Blake machine, and how is the stitch formed?

5.—For what sort of work is the screwer most suited?

## CHAPTER XVII.

### Prime Costing.

For a fuller account, see the present writer's series on "Factory Management and Prime Costing," contributed to the "Boot and Shoe Trades Journal," September and October, 1892.

HOWEVER much one may desire to manufacture only goods of the very highest quality, and however much technical skill may be displayed in the actual manufacture of boots and shoes, unless the manufacturer has an intimate knowledge of the principles on which to ascertain the actual cost of the production of such boots and shoes, the whole of his endeavours will speedily be rendered of no avail. It is imperative that the practical boot manufacturer should possess a full and intimate knowledge of the theory and practice of costing.

Many manufacturers seem ever anxious to cheat themselves; they will not consider that this matter and that matter should have any influence in determining the price of such-and-such a production, whereas every matter connected with the expenses of a business is part and parcel of the cost of producing every single pair of boots. Some manufacturers acquire a method of estimating the cost of their productions which is calculated to be of great advantage to keen buyers, and the very quickest method to bankruptcy for the manufacturer which the wit of man could devise. Boots are costed on which no expenses other than the cost of the labour of the actual cutter and of the materials themselves are included, whilst in selling a boot so costed the percentage of supposed profit is at all times deducted in the financial calculations of the manufacturers as net profit. Nothing could be more absurdly ridiculous, yet one hears people wonder how it is we have so many bankrupt boot manufacturers.

Now, against all these pseudo-costings, it is desired to

warn the technical student. The only safe systems are those in which proper self-checking accounts are kept; in fact, in which the double entry system is the underlying principle.

Although the remarks on technical book-keeping which we are about to make may, at first sight, appear to have but little to do with prime costing, they have all and everything to do with it. We will go further, and say that no system of costing can rightly claim to be a correct one unless used in conjunction with proper books. We are fully aware of the difficulty of the task we have undertaken, in endeavouring within the compass of a single chapter to detail the principles of double entry; but if the student will patiently and conscientiously follow our remarks we hope to afford him such a general view of the matter as, by the aid of more extensive works or of a good teacher, will enable him to thoroughly and completely master the whole of this rather complicated, but yet beautiful, system of book-keeping.

Double-entry book-keeping is a system of accounts arranged and kept in such a manner that every transaction is recorded on two opposite sides of the ledger. Thus all the books which are subsidiary to the ledger, and all forms which are contributory to the ledger, must be arranged in double columns designated, according to the science of book-keeping—the left column "Dr." (or Debtor), and the right column "Cr." (or Creditor).

The system may be compared to a pair of balances, the two pans corresponding to the two columns. The two sides of the ledger it is the object of the system to keep balanced and equal. When one side of an account is of a greater amount than the second side, the exact amount required to adjust the account is referred to as the balance. Thus, we hear of firms who have a "good balance," and of those more frequent and more unfortunate who have a "balance the wrong side." The term, then, we see, is no fanciful one, but one which is eminently expressive of a real state of things.

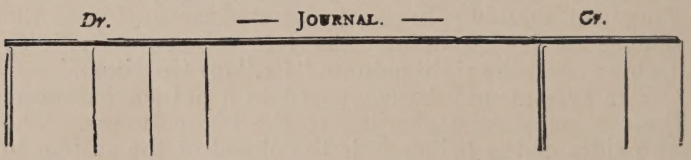
Now, it is quite possible, as we shall presently endeavour to show, to adapt this system of double entry book-keeping to the requirements and necessities of boot and shoe manufacture. The system, when well understood, is a very easy, although a perfect one; and it behoves every manufacturer who is anxious to succeed in business, as well as to succeed in manufacturing high-class

goods, that he should adopt a system such as this, which will readily warn him of any serious deficiency in his manufacturing accounts.

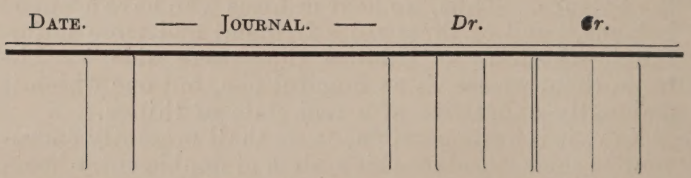
Although it will not be attempted in this elementary manual to particularise a complete system of double entry book-keeping for boot manufacturers, yet we shall endeavour to sketch such a general outline of the books and methods employed in such a system as will render the understanding of the higher applications comparatively easy.

First, then, we shall give an explanation of the books absolutely necessary to the manufacturer; and, secondly, we shall consider the question of costings both upper and bottom stuff, and the manner of "posting" such "costings" into the books as to prove the accuracy of the methods employed. All goods which are purchased, and, in fact, all transactions, should be placed in the first place into a rough day book. This may be ruled in any manner to suit the convenience of the majority of the entries. Being simply a memorandum book for entries previous to the entry proper, any design of ruling is allowable.

In the journal, however, the ruling must be confined to one of two patterns. The form must be either that known as the Government Office folio, as follows:—




Or the following ruling, which is most usual among private firms, may be adopted:—




Before we consider the actual entry of any single item it is first necessary to explain the principles which must determine the side on which transactions of different natures must be recorded.

It has been shown that two sets of columns are neces-

sary—the Dr. and Cr. columns. Now, the difference in the transactions recorded in the opposite columns is this:—On the Dr. side all the transactions are inwards, and on the Cr. side all the transactions are outward. Thus, if we have a "goods account" in the ledger, all goods purchased are placed to Dr. side of the goods account. Why? Because they come in, they increase the value, and are a gain to the account, and are therefore placed to the Dr. side. If, on the other hand, certain goods are sold, then clearly there is so much withdrawn from the account, so much goes out, and the transaction must therefore be recorded on the Cr. side. Thus everything that comes in to an account must be entered on the Dr. side; everything that goes out must be recorded on the Cr. side. The student may remember these distinctions easily by the following aid:—

| Dr. (in). | Cr. (out). |
|---|---|

In the previous paragraph an entry for goods purchased and also one for goods sold was partly explained. Every complete entry must have two places in the ledger; the entries before referred to were but entered in one place, and thus were incomplete. Let us show how the complete entry may be made. We will now suppose the transaction in the first place to be recorded in the day book as follows:—

| | | |
|---|---|---|
| Oct. 12, 1886..... | Mr. John Smith, London, had 12 pairs kid butt., 260 | @ 9/- |

Now, two accounts are involved in this transaction—that of "John Smith, London," and that of "Goods." For the entry to be complete it must accordingly be entered to these accounts respectively, but on different sides in each account. Plainly, Mr. John Smith, London, has the goods, and he is therefore Dr. to them. Further, it is also plain that the goods—the 12 pairs of kid button at 9s. per pair—go out, and that therefore the goods account is Cr. Thus, with these entries properly made, we have one side of one account decreased to the extent of £5 8s., and one opposite side of a second account increased to the like extent. Thus, the ledger as a whole will "balance."

Now, if the principle on which entries are made is thus thoroughly understood, the use of the journal will

be rendered easy. The object of the journal is to simplify the entries to the ledger, and the foregoing transaction would be recorded from the day book to the journal in the following form :—

| 1886. | | Dr. | | | Cr. | | |
|---|---|---|---|---|---|---|---|
| Oct. 12 | Mr. John Smith, London.<br>To Goods. | 5 | 8 | 0 | 5 | 8 | 0 |

By entering the transaction into the journal in the foregoing form the posting into the ledger is a process of the simplest nature. The column in which the amount is placed continuous with the name of the account is the side of that account to which the amount is placed. Thus the amount following the name of Mr. John Smith, being placed in the Dr. column, plainly the account of Mr. John Smith must have £5 8s. recorded on the same side. Further, the amount continuous with the word "Goods," signifying the goods account, being in the Cr. column of the journal, plainly the Cr. side of the goods account in the ledger must have that amount there recorded. Thus the entries would stand in the ledger as follows :—

LEDGER—

*Dr.* —— JOHN SMITH, LONDON. —— *Cr.*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Oct. 12 | To Goods.. | 5 | 8 | 0 | | | | | |

LEDGER—

*Dr.* —— GOODS ACCOUNT. —— *Cr.*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Oct. 12 | By J. Smith | 5 | 8 | 0 |

Now that the principles on which entries are made have been rendered plain, we will consider shortly the usual accounts which a boot manufacturer would open

in his ledger, and then we shall be clear to discuss the actual process of costing.

The book which contains all the accounts of persons and things, and accounts which answer the several questions concerning the profit or loss accruing on certain manufactures is called the ledger.

In order to properly "open" this ledger, certain facts must first be ascertained relating to the manufacturer's possessions or property, his debts, etc.; when these facts are ascertained, the balance sheet is compiled.

We will suppose that accounts are opened from the following balance sheet:—

— BALANCE SHEET. —

| LIABILITIES. | | ASSETS. | |
|---|---|---|---|
| Mr. Jones .. .. | £5 0 0 | Mr. Smith . .. | £25 0 0 |
| Mr. Robertson .. | 12 0 0 | Mr. Long .. .. | 25 0 0 |
| Mr. Brown .. | 6 10 0 | Cash .. .. .. | 50 0 0 |
| Balance (net capital) | 676 10 0 | Bank .. .. .. | 100 0 0 |
| | | Goods .. .. | 500 0 0 |
| | £700 0 0 | | £700 0 0 |

From this balance sheet, then, accounts must be opened, headed with the names given in the balance sheet. Thus the ledger is ready to receive the record of all business transactions as they occur.

Now, of all the accounts, the accounts of goods and of cash will here most concern us, so of those we shall shortly treat.

Already we have on the Dr. side of the goods account the sum of £500 entered. This, we will say, represents raw material, which it is intended to work up into boots and shoes. Now, it is desired to sell these manufactured goods at a profit, which will not only clear all the incidental expenses of wages, shop rent, travellers' expenses, etc., but which will leave a profit such as will increase the capital—which should be the aim of every business man. To ascertain as exactly as possible the cost of manufacturing such goods is the object of prime costing.

In order to illustrate the methods employed to ascertain the prime cost, we shall now take a few examples.

First, we will suppose it necessary to ascertain the cost of some button boots cut from medium calf kid skins, and which are to be cut only from the best parts. They are a specialty. We have to ascertain in this case, in reality, the price at which the best part of the skin cuts. Now, it would never do to estimate the cost of the

specialty to equal the whole value of the skin. The whole of the waste and offal must not be considered as determining the value of the special work cut. Either the roundings must be sold and the price they realise deducted off the original cost of the skin, in order to give the basis for the estimation of the specialty, or commoner work may be run in with the special line. The latter course is by far preferable, for the simple reason that the roundings are always worth more to the manufacturer himself, whenever he can possibly use them, than they would realise if sold to some other manufacturer. However, as the first course is, in some divisions of the industry, compulsory, a sample costing, when the roundings are sold, will be here given.

SAMPLE COSTINGS.

No. I.—SELECTIVE SYSTEM

*Dr.* CALF KID BRAND. *Cr.*

| | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| To 2 doz. @ 80/ per doz. | 8 | 0 | 0 | By 60 pairs @ 2/6 | 7 | 10 | 0 |
| Balance— | | | | | | | |
| Profit .. .. | | 5 | 0 | „ Roundings @ .. | | 15 | 0 |
| £ | 8 | 5 | 0 | £ | 8 | 5 | 0 |

The account is thus debited with the value of the skins themselves, and credited with that which it produces or which is withdrawn from it. The roundings are withdrawn, and are therefore placed on the Cr. side of the account, making it balance. In this method of calculating the cost of the work, the price realised by the roundings must be deducted off the original price of the skins, and the net price must be divided by the number of pairs produced to obtain the price for each single pair. No allowances or deductions should be made at this point for slow selling stuff or other such matters. Those are matters which must be considered when adding the actual profit. If the line is a slow selling one, or has some characteristics which render it costly to distribute, then the percentage of added profit should be proportionately higher; but all such calculations as these should be made after the real actual cost of the article has been ascertained. It is lamentable to think that many manufacturers are ruining themselves and the trade generally by numberless sophistries in the process of the prime costing of their productions.

Skins are also cut into special work, as before referred to, by running commoner work into the less valuable

parts of the skin instead of selling such parts to other manufacturers. Although this method is decidedly to be preferred to the former one, it nevertheless presents a more profitable field for what we have termed "the sophistries of costing." Thus, when costing skins so cut, many manufacturers estimate the price of the commoner work on the basis of the price of the actual skin then being cut. Well, one may think, surely this must be correct; there can be no sophistry about this method? But yet probably more losses occur by costing both common and best work cut from one kind of skin on one basis. Let it be remembered that the prime object is to cost this "special line." Remember that the commoner goods are but "run in" with them. Let it be remembered, further, that there is an equal probability of the ready sale of the commoner as of the best qualities, and that numerically more of the best quality work is produced from the skins than of the cheaper and commoner. Now, presuming that the skins have been costed on this system, on the basis of the actual cost of the skins, that is, on some arbitrary system of deducting from the average for the commoner, and adding the amount so deducted to the average for the best; presuming further that the demand for the common boot so cut and costed is so great that it is impossible to obtain sufficient by merely running them with best work; then they would have to be obtained from skins which would produce an equal quality of boot at the same price. Too often, on the foregoing system of costing, such a quality of boot cannot be produced at such a price, and then the boot has to be cut at a loss.

Now, this could easily be prevented by adopting a method of costing equally simple; in fact, simpler, and far more reliable. Find the average by dividing the cost of the skins by the number of pairs cut; count the number of the commoner quality cut; and value them at the price they could be produced in any quantity from other skins. Add the difference between such price and the average to the average price, which will then give the exact price for the best quality.

In costing, the skins should always be cut up as closely as possible—that is to say, the button piece linings and button stays should as far as possible be cut out of the pieces made in the cutting in order to facilitate the process of costing.

When skins are cut and the roundings sold, such a

method of cutting is referred to as "selective." When the whole of the leather is cut up, such a system is spoken of as the "exhaustive." A sample of "selective" costing is given in sample costings No. I. A specimen of costing under the "exhaustive" method is given in sample costings No. II. Let it be particularly noted that even in these costing sheets—which are really only memoranda—it is always advisable to adopt the Dr. and Cr. column arrangement; it is by far the neatest method and hence more calculated to prove correct.

SAMPLE COSTINGS.

No. II.—EXHAUSTIVE SYSTEM

CALF KID BRAND XX 29.

| *Dr.* | £ | s. | d. | | £ | s. | d. | *Cr.* |
|---|---|---|---|---|---|---|---|---|
| To 1 doz. @ 80/ .. | 4 | 0 | 0 | By 24 pairs 220 @ 1/6 | 1 | 16 | 0 | |
| | | | | ,, 15 ,, 096 @ 2/ | 1 | 10 | 0 | |
| Balance .. | | 3 | 6 | ,, 7 ,, A265 @ 2/6 | | 17 | 6 | |
| £ | 4 | 3 | 6 | £ | 4 | 3 | 6 | |

Having considered leathers, which are costed solely by measurement, leathers the cost of which is determined in a large measure by their weight will now be considered.

The principles of costing laid down in the consideration of calf kids are as equally applicable to all classes of leather. That is to say, such principles as the costing of cheap work from skins which would produce such in any quantity must be adhered to in cutting calf as in cutting kid. The great difference is this, that, whereas in the costing of calf kid the quality is determined by the substance and texture without regard to weight, in the costing of waxed calf the quality is determined by the weight as well as by the texture. Thus the main difference in the process of costing such leather as waxed calf from the process employed in costing calf kid consists in the determination of the particular value, having the weight as basis. It is known how much per pound avoirdupois the whole of the skin costs; it remains to determine the price per pound avoirdupois that certain selected parts shall be valued at.

To determine this the weight of the offal must first be found. Fittings must be valued at a price at which they could be cut to answer the purpose from some material which would yield them alone in any quantity. That amount which the fittings are priced at per pound below the prime cost per pound of the leather must be

added to the same prime cost, in order to fix the price per pound for the prime leather. Sample IV. of the prime costing specimens demonstrates our meaning. All particles of leather, however small, under this system of costing must be weighed and costed, as their proportion and amount equally with the other portion determine the value.

SAMPLE COSTINGS.

No. III.—Waxed Calf.

| *Dr.* | £ | s. | d. | | £ | s. | d. | *Cr.* |
|---|---|---|---|---|---|---|---|---|
| To 47 lbs. @ 4/2 per lb. | 11 | 4 | 0 | By 5 lbs. Offal @ 11d.[1] | | 4 | 7 | |
| | | | | ,, 6 ,, Neck @ 1/6 .. | | 9 | 0 | |
| | | | | ,, 11¼ ,, Thin[2] @ 2/4 .. | 1 | 3 | 0 | |
| | | | | ,, 24½ ,, Prime [Produce @ 7/8 .. | 9 | 8 | 0 | |
| ,, Balance .. .. .. | | | 7 | | | | | |
| £ | 11 | 4 | 7 | £ | 11 | 4 | 7 | |

(1) These are *cuttings*, many of which would sell for patches, &c, at the price given.

(2) Suitable for, and in fact cut into, linings. Note the addition to the cost of the prime produce of the deduction from the linings.

Thus, by the methods explained in the foregoing paragraphs, the prime cost of the uppers could be readily ascertained.

We have now to consider the methods employed in the costing of sole leather. In this process the butt to be costed must first be weighed. Next take off the fore-ends and price them, having for a basis the price per pound of the whole butt. Now range up the butt as far as the necks, and let the rough stuff cutter cut these ranges up into soles and top-pieces. Now, if 4d. per pound be allowed on the cost of the range, when the returns from the pressmen are weighed they will show a slight profit. The edge-pieces are, of course, to be priced before weighing. The following is a sample costing of a 20lb. butt:—

SAMPLE COSTINGS

No. IV.—Sole Leather.

English Butt.

| *Dr.* | £ | s. | d. | | £ | s. | d. | *Cr.* |
|---|---|---|---|---|---|---|---|---|
| To 20 lbs. Butt. @ 1/6½ | 1 | 10 | 0 | By Ranges: 14 lb. 7 oz. @ 1/8[1] | 1 | 4 | 1 | |
| | | | | ,, Edge Pieces: 3 lb. 6 oz. @ 1/4[2] | | 4 | 6 | |
| ,, Balance .. .. | | | 10 | ,, First Cuts: 2 lb. 5 oz. @ 1: | | 2 | 3 | |
| £ | 1 | 10 | 10 | £ | 1 | 10 | 10 | |

(1) Result when returned from pressman of a single range :—

| | | | | | |
|---|---|---|---|---|---|
| Weight of range 3 lbs. at 1/8 = | 5 | 0 | *Returns*—Soles, 2 lb. at 2/ = | 5 | 1½ |
| | | | 9 oz. (4d. per lb. added) | | |
| | 5 | 0 | | 5 | 1½ |

(2) Thin edge pieces running off light.

Having explained, then, the methods for obtaining a primary costing, it is now necessary to give the sequel to the introductory portion of this chapter and show how by a system of book-keeping any "leakage" or falling-off in the standards thus fixed may be detected. Many are the costings which are made—and which have proved, apparently, to their makers—to show a remunerative balance, but yet somehow the business of boot manufacturing with them does not prove to be so profitable as their costing sheets would appear, to them, to indicate should be the case. When such an event occurs, the explanation can only be given by properly kept books. We shall now endeavour to complete this chapter by the completion of our consideration of double entry.

First, we will consider the books and forms indispensable and peculiar to the clicking room.

A small ledger, subsidiary to the main ledger, should be kept, into which every parcel of leather should be entered with a separate account. Thus, suppose a parcel of twelve dozen calf kids at 100s. the dozen were purchased, the account in the ledger would be headed with the name of the leather, a full description of the particular brand, and also with the name of the firm of whom the goods were obtained, whilst the actual value of the skins would be recorded in the Dr. column of the account. Now, all that the skins realise must be placed in the Cr. column, for the simple reason that so much is withdrawn from the account and placed to the debit of a "manufactured goods account."

Now, it is not always possible, nor advisable, in actual business, to cut up the whole of a parcel of leather at one cutting; neither would it be practicable to record in this ledger, at each time of cutting, the amount or value then realised. But, still, such records must be kept. To keep the records is vital to a proper knowledge of the financial condition of the business, and also of particular manufactures.

In order to facilitate the entries, properly ruled cards should be attached to the skins. The cards should be numbered, the number of the card to correspond with

the number of the account of the parcel of leather in the ledger.

This card would then serve as the day book to the leather ledger referred to in the previous portions of the chapter; it is, in fact, the rough record of "transactions" concerning the various parcels of leather. The card given here would be the rough unentered record of

SAMPLE CLICKER'S CARD.

L. No. 5768. DATE IN..*Sept, 9th*, 1886. CLICKER'S No. 68.

| No. of pairs cut. | Cutting No. (1). | Price. (2) | Total. | | |
|---|---|---|---|---|---|
| 12 | 260 | 9/- | 5 | 8 | 0 |
| 24 | 078 | 7/3 | 8 | 14 | 0 |
| 36 | 0965 | 10/6 | 18 | 18 | 0 |
| 6 | 274 | 11/- | 3 | 6 | 0 |
| | | TOTAL .. | £36 | 6 | 0 |

(1) By "cutting number" is to be understood the number in the list of manufactures which denotes the particular quality and description of boot or shoe cut.

(2) The estimated price as recorded in the ledger before referred to.

"transactions" concerning the parcel of leather recorded on folio 5,768 of the leather ledger; and thus all the amounts recorded on this card would be placed after passing through the journal, to the credit of the 5,768 folio, and to the debit of an account, of which we shall presently give an explanation, called the "manufactured goods account."

The statement in the journal would be:—

| | *Dr.* | | | *Cr.* | | |
|---|---|---|---|---|---|---|
| | £ | s. | d. | £ | s. | d. |
| Manufactured Goods a/c ... ... ... | 36 | 6 | 0 | | | |
| To Folio 5768 ... ... ... ... | | | | 36 | 6 | 0 |

The same principles should be employed in the rough stuff department, as well as in the whole of the other departments. All these accounts will form the material for the manufactured goods account, of which we shall now treat.

To this "manufactured goods account" all the entries from the subsidiary ledgers which refer to the manufacture of the goods and all the cash expended on wages for the manufacture of such goods must be debited. Thus, on the debit side of the account will be placed a record

of every conceivable expense connected with the manufacture of the goods to be sold. When any goods are sold they must be credited to the account. Thus, to repeat a previous example, if Mr. John Smith, London, purchases 12 pairs kid button boots at 8s. per pair, the transaction would appear in the journal :—

| | *Dr.* | | | *Cr.* | | |
|---|---|---|---|---|---|---|
| | £ | s. | d. | £ | s. | d. |
| Mr. John Smith, London ... ... ... | 4 | 16 | 0 | | | |
| To Goods ... ... ... ... ... | | | | 4 | 16 | 0 |

Thus, if the foregoing entry were correctly posted, the transaction, as before shown, would appear in two distinct and opposite places in the ledger, one of these places being the Cr. side of the goods account. Now, is it not apparent that, if after losses and such like have been added to the account, the credit side of the manufactured goods account shows an increase over the debit side, there is clear and unmistakable proof of financial success in the manufacture of these goods?

To obtain such clear proof is the object of all book-keeping, and however simple a system may be, it is utterly useless to any practical manufacturer unless it demonstrates plainly to him that his business is a success, not alone in the production of high-class goods, but also of goods that pay. If, then, the system we have endeavoured to sketch with a rapid pen does at first sight appear a little troublesome and complicated, let it be remembered that, as correctness is attainable by its means, the trouble should be but a secondary consideration.

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